Resource Management in Asia-Pacific

Working Paper No. 4:

Exotic plant species in Vietnam's economy—the contributions of Australian trees

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Paper for seminar on Environment and Development in Vietnam, 6-7 December 1996
National Centre for Development Studies, The Australian National University, Canberra

Also presented in the Resource Management in Asia-Pacific Seminar Series
The Australian National University, 22 May, 1997

The correct citation for this publication is:

Author: Stephen Midgley, Khongsak Pinyopusarerk, Chris Harwood and John Doran
Year of Publication: 1997
Title: Exotic plant species in Vietnam's economy—the contributions of Australian trees
Series: Resource Management in Asia-Pacific Working Paper No. 4
Publisher: Resource Management in Asia-Pacific Project, Division of Pacific and Asian History, Research School for Pacific and Asian Studies, The Australian National University
Place of Publication: Canberra
ISSN – 1444-187X

Resource Management in Asia-Pacific

Working Papers

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Abstract

Exotic plant species are playing a significant role in Vietnam's rural economy and provide basic needs of food, fuel and shelter. Australian tree species, notably the acacias, casuarinas and eucalypts have become a common feature of Vietnam's rural landscape and provide considerable economic, social and environmental benefits. The uses of these species are highlighted in a study of exotic species in rural land use in four villages in Quang Tri Province.

Exotic plant species in Vietnam's economy—the contributions of Australian trees

Vietnam is part of one of the world's "mega-diverse" regions, endowed with a rich flora which is socially very important, providing food, medicines and a vast array of other goods and services. In addition, exotic species have long been a feature of the landscape and have become integrated into the broad spectrum of daily life. Food crops such as peanuts, maize, sweet potatoes and cassava, fruits such as guavas, pineapples and the common mango, cash crops such as coffee, cashew and rubber, and common ornamental and timber trees such as frangipani and mahogany have all been taken from other places and assessed, often over many hundreds of years, by farmers and land managers eager to make the best and most profitable use of their land (see Appendix 1). There is an active public debate concerning the relative merits of indigenous and exotic plant species (particularly trees) in some sectors in the South-east Asian region. Concerns have been expressed in some quarters about allegedly detrimental effects of some exotic species, such as excessive use of water and soil and nutrients.

Exotic species play an important role in the domestic and export economies of Vietnam. Coffee, an exotic to Vietnam, is rapidly becoming Vietnam's most successful cash crop and, by the year 2000, it is planned to add 100 000 ha of new coffee plantations to the 150 000 ha currently under cultivation. Vietnam is the world's eighth-largest coffee exporter with export earnings totalling an estimated US$400 million in 1994, approximately 10% of the country's total exports (Far Eastern Economic Review 1995a). Rubber, a native of South America, is one of Vietnam's major agricultural products with over 240 000 ha planted (Warfvinge 1993). Over 70 000 tonnes of rubber with a value of US$70 million were produced in 1994 (Far Eastern Economic Review 1995b). Exports of cashew, a native of north eastern Brazil, totalled US$ 100 million in 1995, accounting for about 2% of Vietnam's total exports. Raw cashew production has increased to 100 000 tonnes in 1995 from 15 000 tonnes in 1987 and Vietnam is now third among the world's cashew exporters - behind India and Brazil. It is expected that production will continue to rise as significant new plantations have been established in recent years (Far Eastern Economic Review 1996). Estimates of production of sweet potato, an exotic staple in many parts of Vietnam, vary, however in 1991 it was estimated that over 2 million tonnes were produced (The Statesman's Yearbook 1991-92).

Deforestation rates in Vietnam have been high with net annual loss of forests estimated at 100 000 - 125 000 ha in recent years. Over the past 50 years the area under prime, accessible native forest available for production of sawn timber is estimated to have declined from 60 per cent to 4 per cent of the land area of Vietnam. Serious efforts are being made to establish forest plantations in Vietnam and the planting rate in recent years has been of the order of 100 000 - 120 000 ha per year, with a parallel program of plantings as scattered trees in home gardens, and along dykes and roadsides of some 400 million trees per year (Interforest 1995). Policy changes in Vietnam have given local people the right to use land for private forest plantations. Local demands for industrial wood, in combination with improved market prices as part of the process of economic rationalisation, have already proven to be the driving forces towards the reforestation of barren land and private tree planting in home gardens and on marginal lands alongside roads and dykes.

Exotic tree species have become a part of the landscape of Vietnam and other countries in the region. Australian trees have been a part of this suite of commonly used species for a long time (Table 1). The eucalypts, acacias and casuarinas have all found important niches in rural land use.

Australian tree species are widely used in community forestry for firewood, poles, shelter and amenity planting. They are also important as plantation species for commercial wood produce such as pulpwood for paper, pilings, lumber and woodchips for export. They are used in a variety of land use systems - around homesteads, on farms and barren lands and along roadsides under land tenure systems including state farms, "communal" and "open access" lands, religious reserves and private holdings. Products commonly derived from smallholder plantings owned and managed by villagers and small communes include fuelwood, poles, woodchips for export, small lumber and furniture, essential oils, honey and tannins. They are also useful components in sustainable farming. Casuarinas, for example, provide protection to homes and agricultural fields from typhoons and desiccating westerly winds, stabilise moving dunes and provide valuable organic matter for farming.

Table 1. Areas planted with Australian trees in Asia (hectares)[1]

Country	Eucalypts	Acacias	Casuarinas
Bangladesh	12 000		
China	670 000[2]	20 000	300 000
India	2 500 000[3]	45 000	800 000
Indonesia	80 000	500 000	
Laos	6 2500		
Malaysia	8 000	200 000	
Myanmar	40 000		
Nepal	6 000		
Pakistan	10 000		
Philippines	10 000	45 000	
Sri Lanka	29 000	6 000	3 500
Thailand	195 000	20 000	
Vietnam	350 000[4]	80 000	120 000

Fuelwood. Several Australian species are extremely important as fuel but the monetary values do not find their way into the formal economies. Fuelwood provides most of the basic energy needs for rural communities in Asia. In Vietnam some 33 million tonnes (equivalent to 55 million m^3) are consumed as fuel annually[5] (FAO 1993). Traditionally this has come from natural forests, but an increasing proportion is now being derived from farm and woodlot plantings of Australian species. Sale of farm-grown fuelwood of eucalypts and casuarinas in Quang Tri Province was shown to contribute greatly to on-farm incomes by Midgley *et al.* (1995) and, when used as household fuel by the grower, had a replacement monetary value equivalent to 60 kilograms of rice per year.

[1] Eucalypt figures derived primarily from papers presented in FAO (1995). Blank spaces indicate no reliable information has been located.

[2] Does not include "four-round" community plantings equivalent to approx. 1.2 million ha of plantation.

[3] Dewees and Saxena, 1995.

[4] Does not include "scattered trees' equivalent to 700 000 ha of plantation.

[5] Compare with Australia's annual removals from its forests totalling c. 18 million m^3

Poles. Roundwood is commonly used in house and building construction in Vietnam and the acacias, eucalypts, melaleucas and casuarinas are widely used for this purpose. Straightness of stem is a major attraction of selected species of these genera and one of the main criteria governing species choice for farm plantings.

Woodchips for export. The opportunity to generate cash incomes has made eucalypt and acacia growing for export woodchips an attractive option for many small farmers, provided an infrastructure for purchase and transport exists.

Small lumber and furniture. Small sized logs are converted to lumber in village-level saw mills. This lumber is used for low-priced furniture and general construction and finds its way into schools, hospitals and private homes.

Essential oils. Eucalypts and melaleucas offer very early returns to investment by farmers through production of leaf oils. Harvesting green leaf early in the rotation diminishes wood production, but offers farmers an opportunity to recoup their costs of establishment. Growers in Vietnam have recognised the opportunity for value-adding from their eucalypt and melaleuca plantings through production of foliar oils and are currently investigating ways in which this can be enhanced.

Casuarinas

For over 100 years, casuarinas (*philao*) have been a part of a useful array of exotic woody species which contribute to profitable and sustainable land-use in rural Vietnam. They have found a particular niche on fragile sandy coastal landforms where *C. equisetifolia*, a species tolerant to salt spray, is in wide spread use. Substantial areas of casuarina have been established along sea-fronts, around villages, homesteads, roads, farmers' fields and plantations now totalling 120 000 ha. For a full description of their history and use in Vietnam see Ha Chu Chu and Le Dinh Kha (1996). In coastal areas of southern China plantings on similar land forms increased to more than 1 million ha before falling to the current 300 000 ha (Bai and Zhong 1996). The patterns of adoption of these plantings are strongly influenced by land tenure, farmer resources and social customs.

In coastal districts of central Vietnam, protective plantations of casuarina have contributed significantly to sustainable land use through stabilisation of shifting sands, amelioration of harsh site conditions and provision of firewood and other wood products. As informal village and farm plantings they have become an integral part of farming systems on sandy, infertile sites. Their contribution to the local economies and social well-being of the area was the subject of a study conducted in Vinh Hoa village, Quang Tri Province, in November 1994. With a very conservative array of assumptions, an economic assessment of casuarina tree-farming in Vinh Hoa indicated a favourable financial return to growers (internal rate of return, IRR, of 28%), in addition to significant local benefits of site amelioration and additional supplies of domestic fuelwood. A more optimistic scenario suggested an IRR of 65%. Unprecedented levels of casuarina planting in this village reflect these higher economic benefits.

The main economic product from casuarinas is fuelwood for which there is a strong local demand. As people have greater financial resources because of national economic reforms, they invest in traditional family homes which are constructed of brick and mortar. The large fuelwood needs of brick and tile kilns underpin the current high demand for fuelwood (Midgley *et al*. 1996).

In addition to the direct contributions to household income via sale of fuelwood and poles, the casuarinas provide the framework for a very successful agroforestry system. It is estimated that 90 kg/ha of atmospheric nitrogen can be fixed annually at a planting density of 2000 trees/ha (Doran and Turnbull 1997). The adoption of local agricultural technologies has enabled farmers to be self-sufficient in casuarina planting material and to sell excess seedlings in the local markets. It is not an exaggeration to say that the casuarinas guarantee the sustainability of the farming systems in sandy coastal environments.

Eucalypts

It is estimated that between 300 - 400 000 ha of eucalypt plantations have now been established in Vietnam. Scattered trees planted around farms, homesteads, roads and villages are equivalent to an additional 700 - 800 000 ha (Tran Xuan Thiep 1995). The most commonly used species is *E. camaldulensis*.

Farmers' contribution of their labour and time on planting eucalypts can be profitable business in rural Vietnam, paying 3 to 4 times the wages from alternative activities in agriculture (Midgley *et al.* 1995). At a site in Quang Tri Province, the first rotation of *E. camaldulensis* at year 7 provided a nett revenue of 10 million dong per ha (US$1.00 = Dong 11 000) representing an IRR of 28%. At the completion of a further coppice generation at year 13, 11 million dong were earned representing an IRR of 32%. An example of the attractiveness of planting eucalypts was provided by one farmer. One million dong invested in a cow will yield 1.5 million dong after 5 years through the sale of three calves. For one million dong the farmer can plant 2 hectares of eucalypts and gain a nett revenue of 18 million dong after 7 years. Small growers are finding ready markets for eucalypt poles through the construction boom in the major cities, and in the emerging market for export wood chips through the ports of Da Nang and Ho Chi Minh City.

Commercial fuelwood (eucalypt stems) is sold at D70 000 per stere[6], stacked at the roadside. If a farmer sold standing trees, he would receive about D50 000 per stere, i.e. the payment for his labour in cutting, carrying to roadside and stacking is D20 000 per stere. Domestic and local fuelwood (branches and twigs) has a market value (or opportunity cost if used within the household) of about D8 000 per 30 kg load (Midgley *et al.* 1995).

Exports of wood chips from Ho Chi Minh City and Da Nang have begun to provide economic benefits at the village level and eucalypts offer one of the few land use options for poor farmers to generate cash incomes. In central Vietnam, farmers tend to prefer *E. camaldulensis* because they find it easy to grow: it will grow in poor soils and the trees are generally straight and are easy to market and utilise. The form of the tree is important to the farmer as a straight tree can realise three times the price of a crooked one.

Demands for seedlings at the village level and limited resources have resulted in innovative decentralised systems for seedling production. Most seedlings are raised in polythene tubes, but with few resources for modern nurseries, it is common to see the application of "paddy technology" to the raising of eucalypt seedlings. As with rice, seed is broadcast sown into prepared beds of wet soil and kept moist until germination. The seedlings are left to grow *in situ* and are pulled from the soil as naked root planting stock when required. Planting is carried out in small batches as and when time and resources allow. Technical considerations such as spacing are frequently worked out through trial and error and change quickly with perceived market possibilities.

In 1988, villagers operating private nurseries around Ho Chi Minh City were prepared to pay a premium for seedlings of the fast-growing provenance of Petford. In recent years growers in southern Vietnam have noticed that this provenance is susceptible to a suite of fungal pathogens (Sharma 1994) and other seed sources (especially the Morehead and Kennedy River provenances) or species (such as the tropical acacias) have found favour because they are less susceptible to foliar diseases. On sites which are less humid (and more suitable for eucalypt cultivation) the problems relating to disease are less severe. The Forest Science Institute of Vietnam (FSIV), CSIRO Forestry and Forest Products and the Australian Centre for International Agricultural Research (ACIAR) have recognised the threat that pathogens present to sustainable production and commenced a project in 1996 designed to reduce the disease impacts on eucalypts.

Eucalypt growing is not without market dangers. There are examples in India (e.g. Dewees and Saxena 1995) where adoption of eucalypt woodlots by farmers has been followed by de-adoption when a glut in timber on rural and urban markets causes a collapse in the market. Planters who grew eucalypts to meet early market demands found eucalypts to be a lucrative crop, but later growers found it difficult to compete in wood markets which were becoming saturated. Losses in farm revenue due to crop losses resulting from competition for water and nutrients with eucalypts on field boundaries have been reported (Saxena 1991a) and this will influence decision making by landholders. Saxena (1991b) also found in north-west India that legal restrictions to the transport and sale of wood acted as a disincentive

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[6] A stere is a stack of 1 m^3 gross volume, which, according to the size of individual prices and stacking density, usually contains about 0.65 - 0.7 m^3 of actual wood.

to investment in eucalypt planting. The current demand and opportunities for wood products in Vietnam are currently such that it would appear unlikely that these problems would emerge in Vietnam in the foreseeable future.

Acacias

In the early 1960s, sixteen Australian *Acacia* species were introduced into Vietnam for testing, but from these first introductions only *A. auriculiformis* was widely adopted for planting, mostly in southern provinces. The seeds used for plantations were mostly derived locally from south-eastern Vietnam, but the natural provenance origin is not known. More recently, among many *Acacia* species tested in Vietnam, A. *mangium* became an especially preferred species. Out of about 913 000 ha of forest plantations established during the period 1986-1992, *A. auriculiformis* constituted 4.5 % (43 000 ha) and A. *mangium* 2.5 % (23 000 ha) (Ministry of Forestry 1994). At present, acacia wood is used as raw material for the paper industry, and for other purposes including fuelwood. The planting of acacias will be increased in the next few years, up to an annual rate of 10 000-15 000 ha per year. Acacias are becoming increasingly favoured over eucalypts as large-scale plantation species because they are perceived to be more environmentally benign, being nitrogen fixers and producing a leaf litter which is more protective of the soil. Also, they have not suffered the leaf pathogen attacks which have been experienced on some eucalypt provenances in southern Vietnam. In intensive agricultural systems at an altitude of 380 m near Khe Sanh, *A. auriculiformis* is commonly used, along with avocado, as a windbreak around coffee and pepper fields (Midgley *et al*. 1995). It is easy to propagate and to maintain, and when mature can be used for small furniture.

Growth potential of acacias in southern Vietnam is better than in northern Vietnam. For A. *mangium*, mean annual increment is about 2.0 m/year for height and 2.0-2.5 cm/year for diameter at breast height (dbh) in northern provinces, while in southern provinces growth is 2.5 m/year for height and 3.0-3.5 cm/year for dbh. In some cases, 4 m/year for height and 5 cm/year for diameter are achieved in early years. *A. auriculiformis* in commercial plantations also shows good growth: 2.4-2.8 m/year for height and 2.5-2.8 cm/year for diameter for the first 4-6 years in southern Vietnam (Nguyen Hong Nghia and Le Dinh Kha 1996). In trials as well as in commercial plantations, productivity is generally low if intensive cultivation measures or agroforestry techniques are not applied. By using suitable soil preparation, tending, weeding, fertiliser, and soil mulching, productivity of plantations can be considerably increased, especially on poor, dry sites.

Since 1982, the Forest Science Institute of Vietnam in collaboration with other local and overseas forest research agencies has established acacia species/provenance trials at 8 locations in 6 provinces throughout the country (Nguyen Hong Nghia and Le Dinh Kha 1996). Most seedlots for testing were supplied by CSIRO's Australian Tree Seed Centre (ATSC). *A. auriculiformis*, *A. crassicarpa* and *A. mangium* were identified as the acacia species with greatest potential for the most common available planting environments in Vietnam. Climatic requirements for *A. auriculiformis* and *A. mangium* have been determined (Nguyen Hong Nghia 1996). There is an area of some 200 000 ha of sandy soils on the south-east coast where the rainfall is too low for these species. Species trials have shown that *A. difficilis* and *A. tumida* have excellent potential for dune fixation and wood production on these drier site types, with growth rates and survival far superior to indigenous or other exotic alternatives.

In 1995, the Research Centre for Forest Tree Improvement (part of FSIV) began the establishment of comprehensive base and breeding populations of the best provenances of *A. auriculiformis* and *A. mangium*, in collaboration with ATSC and with financial support from AusAID for the FAO regional tree improvement project (FORTIP). These base populations will provide Vietnamese researchers with the genetic base to commence advanced-generation breeding to improve vigour, form and adaptability to particular environments.

Another development of great promise is the identification of *A. mangium* x *A. auriculiformis* hybrids as having outstanding growth potential (greatly superior to the two parents) and excellent wood properties. Outstanding clones have been tested and are being mass-propagated for operational clonal forestry - as yet on a modest scale (Le Dinh Kha 1996).

Melaleucas

The Mekong Delta of Vietnam covers a land area of some 3.59 million ha and supports over 15 million people. Soils over 41% of the area are classified as acid sulphate and one third of these are regarded as highly acid, with forestry the preferred and perhaps the only practical sustainable land-use option (Nguyen Duy Chuyen 1995). Dense forests of *Melaleuca cajuputi* once occupied most of the seasonally inundated, acid sulphate soils of the Delta, principally on Ca Mau Peninsula, in the Long Xuyen Quadrangle and on the Plain of Reeds. They were an important source of wood (e.g. firewood, posts, poles and piling) and non-wood (e.g. wild game, fish, honey and essential oils) products for local communities and had significant environmental benefits such as flood mitigation and maintenance of water quality and wildlife habitat. It is estimated that today only 121 000 ha of natural melaleuca forests remain in the Delta and about 5 000 ha are lost annually through illicit cutting and burning (Nguyen Duy Chuyen 1995). The wastelands created by this process have high priority for reforestation.

The environment for tree establishment and growth on these denuded lands is very difficult. Two approaches to forest establishment on them are possible, either modifying the edaphic conditions to the extent that the site is suitable for a range of species (e.g. *Eucalyptus* and *Acacia* spp.) or selection of species that are adapted to the difficult conditions (e.g. *Melaleuca* spp.) (Simpson 1995). The first approach is aimed at high yields but requires a large capital investment in drainage works and can cause serious problems if mismanaged resulting in acidification of waterways. The second approach requires young plants to be tolerant of highly acid water and soils (pH of 2.5-4.5 during May-July, Nguyen Thi Bich Thuy 1995) and associated aluminium toxicity and nutrient imbalance, long periods (up to 5-6 months) completely under water, and severe weed competition and risk of fire in the dry season. It is more benign on the environment and far less capital is required but comes with the cost of lower yields. The indigenous *M. cajuputi* is adapted to the difficult conditions and can be established without costly earthworks, but is relatively slow growing and subject to dieback of growing tips during times of stress (Simpson 1995). It is important to identify alternative tree species for use with *M. cajuputi* in reforestation of the acid sulphate soils that give higher wood yields while providing a similar range of non-wood products. This was the principal aim of a joint project (1993-1995) between the Forest Science Sub-Institute of Southern Vietnam and CSIRO Forestry and Forest Products with funding support from ACIAR.

The outstanding result from the three trials established in the Delta by this project was the superior survival and growth rate of provenances of *M. leucadendra* from northern Australia and Papua New Guinea to all other material under test. In the trial without mounds, *M. leucadendra* was the only species to give reasonable survival (68-80%) and was significantly taller (1.7-2.1m) at 2 years than all other species. The eight Vietnamese provenances of *M. cajuputi* in this trial performed poorly, with only 35% survival overall. This result is especially significant as establishment without mounding is standard practice with melaleucas in the Delta. As *M. leucadendra* has the potential to become an important species for the reclamation of the acid sulphate wastelands of the Mekong Delta, steps should now be taken to assemble base populations of this species in Vietnam, as a prerequisite to establishing seed orchards and tree improvement programs.

Case studies on the use of exotic species in 4 Vietnamese villages

In 1994 a study to assess the local use of exotic plant species was conducted in four villages in Quang Tri Province (after Midgley *et al*. 1995). A summary of the results from this survey is provided below.

Vinh Hoa Village - a Casuarina-based economy on coastal sands

Vinh Hoa provided a significant example of how institutional reform (*doi moi*), infrastructure development (construction of an access road) and market access can transform the economy of a poor rural village. Saleable farm produce (casuarina wood) and ready access to local markets underpin a sense of optimism in the community at Vinh Hoa on the coastal sands. Casuarina growing represents one of the few technical options for profitable and sustainable land use on coastal sands of poor fertility. In addition to the direct contributions to household income via sale of fuelwood and poles, the casuarinas provide protection from typhoons and desiccating westerly winds and provide valuable organic matter for farming. They provide the framework for a very successful agroforestry system. The adoption of rice-growing technology in the raising of casuarina seedlings meant that all households had

access to as many plants as they needed. Farmers reported that the technology was so simple that it was now difficult to sell seedlings in the market.

Commercial fuelwood now provides 40-45% of household income, which almost doubled after the emergence of the commercial fuel market and the expansion of casuarina tree-farming. All households reported that they can sell as much fuelwood as they can produce at present. There is also a local demand for casuarina wood for roofing poles, boat masts and oars and furniture.

An economic assessment of casuarina tree-farming in Vinh Hoa demonstrated very favourable financial returns. The two scenarios presented below represent a very conservative and an optimistic assessment of the financial returns from casuarina tree-farming in the village. The calculations are on a per hectare basis, although each plot of land is typically much smaller (eg 0.5 or 0.3 ha). The key differences are that the conservative assessment assumes:

- only 30 steres of fuelwood harvested at age 5 and 40 steres from the second rotation at age 10 (compared to 45 and 50);
- an opportunity-cost of household labour of D8 000/day (compared to D5 000); and
- 147 person days of labour input in plantation establishment (compared to 77 days).

Conservative scenario

30 steres harvested age 5;	40 steres at age 10	
Opportunity cost of household labour:		D8 000/day
147 days of labour input in plantation establishment		
Net Present Value		D2 655 000
Internal Rate of Return		28 per cent

Optimistic scenario

45 steres at age 5;	50 steres at age 10	
Opportunity costs of household labour:	D5 000/day	
77 person days of labour input		
Net Present Value		D5 159 000
Internal Rate of Return		65 per cent

Even under the very conservative assumptions, casuarina plantations are quite profitable, but the current degree of activity and participation suggests that most people believe the potential returns are closer to the optimistic scenario.

Hoa Hiep Village - a pepper and coffee-based economy in the highlands near Khe Sanh

Hoa Hiep had the most equable climate of the four study villages but experiences a severe drought in March-April which limits some agriculture possibilities. Healthy international and local markets for commodities such as coffee and pepper, innovative individuals willing to take advantage of the technical opportunities presented by the good soil and climate and accommodating local leadership have resulted in the people around Khe Sanh being confident of their future.. Local farming systems made considerable use of exotic species and incorporated *A.auriculiformis* as windbreaks, avocado as boundary plantings and eucalypts as small woodlots. Commercial opportunity and market access provided by Highway No 9 provide a stimulus to the local economy. The poor condition of the highway limits options for profitable development for perishable agricultural crops which can be severely damaged before reaching domestic or international markets.

Ban Chieng Village - a traditional highland economy with selected additions of exotic plant species

Ban Chieng village in Huong Hoa District is a Van Khieu ethnic minority village with a distinct culture, traditional agriculture and with strong links to the Lao Thung people in the mountain areas of Laos. The people practice a largely swidden agriculture and have made several strategic exotic additions to their garden systems. The cash economy in the village is sustained by coffee, pepper and fish from farm dams. Eucalypts were used for building poles and fuelwood and were considered a positive part of the village landscape. Most farmers were more comfortable selling their cash crops to middle men (normally the Kinh majority people) rather than attending to the marketing themselves.

Tan Xuan Village - Eucalypt additions to subsistence economy in the central Hills

Tan Xuan village, in comparison with the other villages, is extremely poor as measured by most social indicators (e.g. education, nutrition, employment opportunities). The poor soils of the area are severely compacted and marginal for profitable agriculture and the farmers come with a tradition of subsistence fishing rather than a background of subsistence farming. Eucalypts represented one of the few economic options for land use open to these people. Most farmers were puzzled at the prospect of Government proposals to limit further development of eucalypt plantations. Possibilities for wider use of economically attractive fruit trees were limited because of poor extension services and unavailability of affordable planting material.

In summary, people in these four villages were prepared to try a wide variety of plant species, indigenous or exotic, in an effort to improve on-farm and community production and profitability. During the study, many exotic plant species were observed in common use, including 10 species as agricultural crops (peanuts, chilli, marrow, cassava, sweet potato and maize), 8 species of fruit and cash crops (cashew, jak, papaya and guava) and 10 species of tree (eucalypts, acacias, casuarinas, mahogany) (Table 2).

The study villages were distinctly different from each others on criteria including social and ethnic background of the people, local leadership, agricultural opportunities, market access and environmental conditions. All villages made considerable use of a large number of indigenous and exotic economic plants for agriculture, horticulture and traditional medicines for daily life. Much of the discretionary economy in the villages was dependent upon the products provided by exotic species.

Table 2. Use of exotic species in 4 study villages

Village	Agric. Crops[7]	Fruit/Cash Crops[8]	Trees[9]	Total Exotic Economic Species
Vinh Hoa	10 spp	8 spp	10 spp	28
Khe Sanh	14 spp	14 spp	12 spp	40
Ban Chieng	13 spp	14 spp	9 spp	36
Tan Xuan	10 spp	11 spp	7 spp	28

At no sites were prime native forests being cleared for establishment of plantations of exotic species. The provision of forest products such as fuelwood and building poles from exotic trees has reduced pressures upon remnant native vegetation.

Conclusions

A wide range of indigenous and exotic plant and tree species are used and planted in rural Vietnam, and exotic plant species have become an integral part of farming and other land use systems. Villagers are increasingly relying upon planted trees as most of the nearby native forests have disappeared. Choice of species for planting is influenced by a number of factors including:

- Availability of propagating material as seed, cuttings and seedlings from local nurseries.
- Ability to perform well under local conditions with few additional inputs.
- Unambiguous ownership of produce from planted trees.
- Production of robust produce with a ready market demand.

The social value of trees as measured by rural people is clearly not based upon the origins of the plants, but upon their ability to meet needs and to fit with local management systems.

The true social values of the casuarinas to the local economies of coastal Vietnam are yet to be accurately quantified. The wood values certainly indicate very attractive financial returns, and the value of the protective contribution of casuarina to the farming systems, facilitating agriculture on

[7] Includes peanut, chilli, marrow, cassava, sweet potato and maize

[8] Includes pineapple, annona, jak, pigeon pea, papaya, sapodilla, avocado and guava

[9] Includes eucalypts, acacias, casuarina, gliricidia, leucaena, khaya

inhospitable sandy sites, is far greater than the wood value alone. The social value of sand stabilisation, road and infrastructure protection and agriculture is heavily dependent upon the presence of casuarina trees.

Once the benefits of tree planting were adequately demonstrated and planting material was readily available at reasonable price, farmers in all communities were prepared to plant regardless of the indigenous or exotic origin of the tree.

Policy reform, security of tenure and dissemination of technology have been essential ingredients in the enthusiasm demonstrated for planting both exotic and indigenous economic plants.

The expansion of existing markets, creation of a demand for new products and improvements in road access gave farmers the stimulus to produce more wood.

Exotic plant species will continue to be a feature of the landscape in Vietnam and local people will rely on a blend of indigenous and exotic trees to meet basic needs of foods, fuel and shelter. The Australian acacias, casuarinas and eucalypts contribute to meeting these needs and offer opportunities for income generation at the household and commune level. Products from planting these trees should help to reduce harvesting pressure on Vietnam's declining natural forests.

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Appendix 1. Some commonly used plants exotic to South East Asia.[10]

Latin Name	Common Name	Origin
Crops and vegetables		
Arachis hypogaea	Peanut	South America
Cajanus cajun	Pigeon pea	India
Canna edulis	Canna Lily	South America
Capsicum annuum	Chilli	South America
Ipomoea batatas	Sweet potato	South America
Lycopersican esculentum	Tomato	South America
Manihot esculenta	Cassava	South America
Nicotiana spp	Tobacco	South America
Sechium edule	Choko	South America
Solanum tuberosum	Potato	South America
Zea mays	Maize	South America
Fruits and Cash crops		
Ananas comosus	Pineapple	South America
Anarcardium occidentale	Cashew	South America
Annona squamosa	Custard apple	Central America
Artocarpus altilis	Breadfruit	S. E. Asia
Artocarpus heterophyllus	Jak	India
Averrhoa carambola	Star fruit	Indonesia
Carica papaya	Papaya	Central America
Citrillus lanatus	Watermelon	Africa
Coffea robusta	Coffee	Africa
Elaeis guineensis	Oil Palm	West Africa
Garcinia mangostana	Mangosteen	Malaysia
Hevea brasiliensis	Rubber	South America
Manilkara zapota	Sapodilla	Central America
Mangifera indica	Mango	India
Nephelium lappaceum	Rambutan	Malaysia
Passiflora edulis	Passionfruit	Central America
Persea americana	Avocado	South America
Piper nigrum	Pepper	India
Pouteria sapote	Sapote	Central America
Psidium guajava	Guava	Central America
Punica granatum	Pomegranate	Iran
Saccharum officinarum	Sugar cane	Papua New Guinea
Tamarindus indica	Tamarind	India
Theobroma cacao	cocoa	Africa
Trees and Ornamentals		
Acacia auriculiformis	Acacia	Australia /PNG/ Indonesia
Acacia mangium	Acacia	Australia /PNG/ Indonesia
Allamanda carthartica	Allamanda	South America
Bouganvillea spectabilis	Bougainvillea	South America

Appendix 1 continued

Latin Name	Common Name	Origin
Casuarina equisetifolia	Phi lao	Australia / SE Asia

[10] Based on Midgley (1991)

Delonix regia	Flamboyant	Madagascar
Enterolobium saman	Rain tree	South America
Eucalyptus camaldulensis	Red gum	Australia
E. citriodora	Lemon scented gum	Australia
E. exserta	Gum	Australia
E. tereticornis	Red gum	Australia
E. urophylla	Timor gum	Indonesia
Grevillea robusta	Silky oak	Australia
Khaya senegalensis	African mahogany	Africa
Plumeria alba	Frangipani	Central America
Tectona grandis	Teak	India/Burma/Thailand