species are difficult to propagate and have not been amenable to large-scale planting. Seed formation of native species is often erratic and seed trees are widely separated, so a continuing major effort must be made to collect sufficient seed. Many tropical hardwoods have seed that remains viable for only a few weeks after ripening; this makes seed collection and storage difficult. The seeds are not genetically uniform or from selectively bred stock, and so progeny have variable form and growth rates. Further, seedling establishment requires special care; for example, many species may not grow well in direct sunlight in young plantations and, in consequence, nurse trees may be necessary. Native species often do not respond well to fertiliser application, but with exotics such as eucalypts fertiliser may result in rapid early growth (Jordan et al. 1992).

Australian tree species grown in agroforestry systems can provide a number of benefits – including soil improvement, erosion control, provision of fodder and of shade for livestock and crops, and production of timber and fuelwood. Research evidence of experience with Australian species is now reviewed, with specific benefits and negatives discussed.

Potential of Australian tree species for soil improvement and growth on problem soils

There is evidence of declining crop yields despite increased rates of fertiliser application throughout the Philippines (Dalland et al. 1993). Alley cropping and intercropping technology is emerging as one possibility for allowing continuous cropping on low-fertility sites previously under shifting cultivation. In this system, nitrogen-fixing trees and shrubs are planted in narrow rows between traditional crops (Van Orsdol 1987). The trees contribute to maintaining soil fertility (Danso and Morgan 1993) and prunings can be used for mulching and green manuring, or as fodder for livestock. The trees or shrubs are pruned or lopped back during the cropping season to prevent excessive shading of crops (Danso and Morgan 1993; Tonye and Titi-Nwel 1995). Deep-rooted hedgerows have the potential to add nutrients to the system through translocation from lower soil levels to the surface (Palmer 1998), where agricultural crops can access them. Nitrogen-fixing plants have great potential as a renewable alternative to inorganic fertilisers; the best known and most widely used of these species include *Leucaena* spp., *Flemingia macrophylla*, *Gliricidia sepium* and *Desmodium rensonii* (Palmer 1998).

Very high yielding leguminous trees and shrubs can add up to 500 kg N/ha/yr to the soil, although inputs of 100–300 kg N/ha/yr would be more realistic (Laquihon et al. 1998). For example, Kang et al. (1985) reported that, for the humid tropics, leucaena hedgerows established at 4 m intervals produce the equivalent of 100 kg N/ha/yr, with as many as five prunings per year. Mulching with hedgerow prunings has stabilised maize production at 2 t/ha/yr without added fertiliser. Kang et al. (1985) demonstrated that the maize yield obtained from leucaena leaf materials produced in hedgerows planted 4 m apart was the same as that obtained when 40 kg N/ha was applied to the crop.

Yobterik et al. (1994) investigated the response of corn to incorporation of leaf and twig mulches of *Leucaena leucocephala*, *Gliricidia sepium*, *Cassia siamea* and *Grevillea robusta*. Plots treated with leucaena and cassia performed better than unmulched controls. Gliricidia treatment resulted in high seedling mortality after germination. Grevillea incorporation was found to suppress corn growth. In a similar experiment, Anthofer et al. (1998) investigated the response of wheat to the application of leaf prunings. Grevillea had an adverse effect on wheat seedling growth, possibly due to immobilisation of soil nutrients or allelopathic effects.

Van Orsdol (1987) reported that statistically significant increases in soil nitrogen and organic carbon have been obtained on tropical farmlands using acacia species. Many Australian acacia species are able to grow on infertile soil and degraded *Imperata* grassland, and offer promise in agroforestry to assist soil enrichment. For example, *A. mangium* is used in degraded *Imperata* grasslands in Mindoro, Philippines, to create conditions suitable for eventual establishment of native hardwood and cocoa crops (Evans 1992).

The use of Australian acacias is likely to be beneficial in improving soil nutrition and crop yield. However, Binkley and Giardina (1997) reported that they are aware of no estimates of N-fixation for a number of species which show promise for agroforestry, such as *A. melanoxylon*, *A. auriculiformis* and *A. mangium*. Maghembe and Chirwa (1997) reported that Australian acacias have lower nitrogen concentrations than *Gliricidia* and *Sesbania*. Estimates on the amount of N-fixation are highly variable, depending on inherent plant characteristics, tree age, site factors and soil fertility. Estimates of N fixed for some non-Australian acacias range from <1 to 200 kg N/ha/yr, but generally are in the range 12–32 kg N/ha/yr (Khanna 1998).

Casuarina trees are often used for land reclamation and sand dune stabilisation. Farmers in Papua New Guinea often plant casuarina species prior to fallow as a form of land management (Craswell et al. 1998). Rates of nitrogen fixation of 60–90 kg N/ha/yr in pure stands, and 40–60 kg N/ha/yr in mixed stands with eucalypts, have been reported (Binkley and Giardina 1997).

Several Australian tree species occur naturally within or near coastal or inland sites where soils or groundwater are saline. Examples of species which can grow well under saline conditions include *Melaleuca* spp., *E. botryoides*, *E. camaldulensis*, *E. robusta*, *C. glauca* and *A. auriculiformis* (Marcar and Khanna 1997), and these species can be used to improve saline sites.

Some species produce foliage that takes considerably longer to break down than that of other species, or that contains allelopathic compounds. This may impede crop growth and should be considered carefully before introducing eucalypts to alley cropping. In an experiment on the mulching potential of cassia and leucaena in alley cropping, cassia produced lower yields due to the slow rate of leaf decomposition (Danso and Morgan 1993). Indeed these authors concluded, based on their observations, that alley cropping with cassia was not promising for replacing inorganic fertiliser in maize production and the slow release of nutrients from cassia residuals may result in a short-term nutrient deficiency.

Use of Australian tree species for erosion controling agroforestry systems

The primary cause of nutrient losses in the Philippines uplands is soil erosion (Maglinao 1998), and this poses a major constraint to upland production (Maclean et al. 1992). Most upland soils have low water-holding capacities and low nutrient reserves, and erosion needs to be addressed if increased crop production is to be achieved.

Agroforestry has a number of benefits for upland farmers seeking to control soil loss. Deep-rooted perennials, densely planted on contours, can reduce soil erosion and drought stress by enhancing terrace formation, promoting water infiltration, and providing mulch to reduce the impact of splash erosion and moisture evaporation (Maclean et al. 1992). Alley cropping maize with leucaena hedgerows has been reported to reduce annual erosion to one sixth of the level of ploughed plots (Comia et al. 1994), and substantially reduce water loss.

The presence of ground vegetation and litter is the key to effective control of soil erosion. However, some eucalypts appear to suppress ground vegetation and are, therefore, poor trees to use for protective or rehabilitative agroforestry on steep lands. Species that appear unsuitable for soil erosion control include *E. pellita* and *E. urophylla*, and to a lesser extent *E. grandis*, *E. citriodora* and *E. tereticornis*. *E. camaldulensis* does not show a tendency to suppress ground vegetation; this is possibly due to its narrow crown form.

Australian fodder tree species for agroforestry systems

Many nitrogen-fixing trees and shrubs are excellent animal feed, well suited to incorporation into a forage system (Palmer 1998). Vercoe (1987) reports on a trial of 39 Australian tree and shrub species for assessment of fodder value. *Acacia cowleana*, *A. elata*, *A. parramattensis*, *A. shirleyi*, *Cassia brewsteri*, *Dodonea viscose*, *Melia azedarach* and *Terminalia platyphylla* all showed promising performances, with high digestibility and protein contents and acceptable levels of other nutrients. In addition, *A. ampliceps*, *A. auriculiformis*, *A. deanei*, *A. glaucocarpa*, *A. holosericea*, *A. hylonoma*, *A. leptocarpa*, *A. maconochieana*, *A. mangium*, *A. neriifolia*, *A. plectocarpa*, *A. salicina*, *A. saligna*, *A. simsii* and *Casuarina cristate* all warrant further investigation.

While fodder trees appear of great promise, their value should not be overestimated. Many species contain secondary compounds that reduce the feed value through lowering digestibility or through toxic or irritant effects. For example, many acacia species contain cyanoglucosides, fluoroacetates and tannins (Nair and Muschler 1993). In the case of *Acacia cyanophylla*, the compounds have a negative effect on nitrogen utilisation and actually lead to negative nitrogen retention in animals (Reed et al. 1990). However, compounds in many commonly used non-Australian species, such as *Erythrina*, *Cassia* and *Leucaena*, can be toxic if relied upon too heavily as forage (Van Den Beldt 1990), and diversity in the foliage for livestock appears to be beneficial.

Australian trees for fuel and timber production in agroforestry systems

Three genera – *Eucalyptus*, *Pinus and Tectona* – accounted for 85% of all plantations in the tropics in 1980. Many of these species offer high growth rates as well as having the benefit of past research. However, there is considerable potential to diversify the tree species being grown to offer greater choice to match local environments, grow higher value trees, and plant species which offer other production benefits such as nitrogen fixation.

Australian fuelwood species

Over 90% of wood harvested in developing countries is for fuel (Van den Beldt 1990). One of the most important aspects of design in an agroforestry system is to provide fuelwood. Tree form and ability to grow to a large size are relatively unimportant; the ideal size for domestic firewood is sticks or small poles that can be easily cut or snapped to length, and easily carried. Quick drying, freedom from spitting when burnt, steady burning, and low ash content are all desirable fuelwood qualities.

The regrowth of species that coppice well can be very rapid, and such species may be ideal as short-term rotation crops grown for firewood, poles and pulpwood. Some Australian species which coppice well and produce high-quality fuelwood are *Acacia* spp., *Eucalyptus* spp. (Jha 1995) and *Casuarina* spp. Several million hectares of eucalypts are managed on the coppice system in developing countries, and commonly two or three crops are harvested before replacement of the stumps is needed (Evans 1992).

A study by Peden et al. (1996) on preferred timber species in Uganda found that women favoured *Grevillea robusta* because it had larger and more numerous side branches suitable for fuelwood, while men preferred *Casuarina* spp. because they had straight unbranched stems perceived to have greater value as commercial poles. Puri et al. (1994) compared the fuelwood potential of a number of species based on calorific value. They concluded that the most promising tree species was *Casuarina equisetifolia*, followed in order of decreasing value by *A. auriculiformis*, *Eucalyptus camaldulensis* and *E. tereticornis*. Maghembe and Chirwa (1997) recommended *A. auriculiformis* for community forest programs to supply timber due to its fast growth, high timber density and good coppicing ability. Examples of Australian species grown for fuelwood include

E. camaldulensis in west Africa, *Casuarina* spp. in China, *E. globulus* in the Andes of Peru, Ecuador and Colombia (Evans 1992), and *E. grandis* in India.

Use of Australian species for pulpwood

Turvey (1995) reported on a trial in Indonesia assessing a range of eucalypts and acacias for afforestation and pulpwood production on *Imperata* grasslands. Results indicate that, at 10 months, eucalypts generally produce more wood volume than acacias, but eucalypts generally have greater insect and fungal damage, which results in reduced survival rates and production volume compared with acacias. Of the acacias, *A. mangium* had the most rapid growth. At 30 months it had an average wood production of 57 m^3/ha. A *E. grandis* x *E. urophylla* hybrid grew exceptionally well and produced an average of 36–46 m^3/ha of wood at 30 months.

Turvey (1995) concluded that industrial pulpwood plantations of *A. mangium* can be established successfully on the *Imperata* grasslands using techniques of provenance selection, effective weed control, cultivation and application of NPK fertiliser. *A. crassicarpa* showed promise as a species which has better form and higher wood density than *A. mangium*.

E. grandis is ideal for wood pulp and has been widely planted. This widespread success has displaced other equally productive eucalypts in charcoal and pulp production, even though species such as *E. cloeziana*, *E. paniculate*, *E. citriodora* and *E. maculata* have higher wood density and produce a higher yield and better-quality charcoal (Evans 1992). They are not widely planted because they are not widely known. In Brazil, *E. grandis*, *E. alba* and *E. saligna* are commonly grown for pulpwood (Evans 1992).

Australian species for timber production

There is great potential for the production of timber for construction, poles and high-value cabinet timber. The agroforestry system of particular importance in this context is *taungya*. This is a low-cost method of reafforestation (Van Orsdol 1987) in which the emphasis is on the use of trees intercropped with agricultural crops. As the trees become sufficiently large, shade prevents continuation of cropping and the plot is then operated as a timber plantation. Many of the tropical forestry plantations have been established using this approach, with *E. camaldulensis* being one of the more important species (Nair and Muschler 1993).

Eucalypts are often grown for income generation. Some of the most important timber species include *E. camaldulensis*, *E. globulus*, *E. grandis*, *E. microtheca*, *E. tereticornis* and *E. urophylla*. Because of the spectacular success obtained with several eucalypts when planted on suitable sites and well managed, expectations are high about their potential for timber production. There is, however, a risk of misuse and off-site planting due to failure to identify their ecological requirements (Brown et al. 1997). There is potential for incorporating *Grevillea robusta* for poles and furniture, and *Casuarina* spp. for pole production. Brown et al. (1997) argued that there is evidence that, while acacias may be suitable for small diameter timber, their potential for sawn timber is minimal. Others would disagree.

Australian tree species as shade trees

Gill and Abrol (1987) reported that shading from acacias and eucalypts tends to exert a buffering effect on temperature fluctuations and extremes. *Casuarina* spp. are useful as shade trees in the tropics because of their light foliage and nitrogen-fixing ability. Van Orsdol (1987) reported on the use of *Grevillea* species for shading coffee in East Africa. Baggio et al. (1997) reported on a field experiment in Brazil to evaluate the effect of *Grevillea robusta* on interplanted coffee. *Grevillea* was planted in five densities (26, 34, 48, 71 and 119 trees/ha). Compared to open-grown coffee there was no decline in yield at densities up to 48 trees/ha. Total economic productivity (coffee and *Grevillea*) was higher than that of coffee alone for 34, 48 and 71 trees/ha. Seventy-one trees/ha was also effective for protecting coffee plants against frost, and was judged to be the best treatment.

Use of Australian tree species for windbreaks and shelterbelts

Most published reports demonstrate an increase in crop yields with the introduction of a windbreak. Huxley et al. (1994) reported on the effect of pruned triple-row hedges of *G.robusta*, with 11 rows of maize interplanted, in Kenya. The maize on the downside of prevailing winds frequently had improved growth and yield over the non-sheltered maize, sometimes by as much as 50% for the overall crop and 80% in the tree/crop interface zone. However, some incidences of yield reductions due to windbreaks have been reported – attributed to light and moisture competition between trees and crops.

The effective distance of protection is expressed as multiples of the height (H) of the trees. Most authors report that practical windbreak effects extend to a distance of 15–20 H leeward and 2–5 H windward of the windbreak. Moderately dense windbreaks, with 35–50% porosity from top to bottom, are most efficient (Van Den Beldt 1990). This allows some passage of wind, which reduces turbulence and extends the protected area downwind. Onyewotu and Owonubi (1986) (reported in Van Den Beldt 1990) compared the efficiency of *E. camaldulensis* and *Azadirachta indica* (neem) windbreaks in Nigeria, and found the eucalypts to have a longer protection zone downwind because the middle and top porosities are slightly greater than those of the neem, resulting in less turbulence.

Farmers throughout Africa use windbreaks to protect crops, with casuarinas reportedly lining thousands of canals and irrigated fields in Egypt. Many parts of the Philippines are prone to high winds from typhoons. *Casuarina equisetifolia* is a wind-firm species which suffers relatively little damage from high winds (Evans 1992). Nair and Muschler (1993) recommended the use of some fast-growing species such as eucalypts and casuarinas to set up the windbreak as rapidly as possible. Eucalypts are particularly noted for branch throws as a result of high winds, and preferably should not be planted alone for crop protection in windy locations because they have a sparse understorey.

6. Negative interactions in agroforestry

There are a number of possible adverse effects that trees, including Australian species, can have on the soil and on crop productivity. These include:

- moisture competition between trees and crops;
- production of allelochemicals by the trees;
- nutrient competition between trees and crops; and
- removal of organic matter and nutrients in tree harvest.

Table 1: Allelopathy effects of some Australian tree species

Allelopathic species	Affected species	Reference
Acacia auriculiformis	Rice and cowpea	Jadhav and Gayner (1992)
Casuarina equisetifolia	Cowpea, sorghum, sunflower	Suresh and Rai (1987)
Eucalyptus tereticornis	Cowpea, sorghum, sunflower, potato	Suresh and Rai (1987)
Grevillea robusta	Grevillea seedlings	Webb et al. (1967)

Excessive water extraction by eucalypts

Considerable controversy surrounds eucalypts and their alleged excessive water use. Indeed authorities in some regions in India ban their planting. It is argued that crops grown beside eucalypts suffer severe moisture competition and have low yields (Evans 1992). Rao et al. (1990) examined the impact of moisture extraction by a 3.5-year-old *Eucalyptus tereticornis* plantation on yield of mustard and wheat growing next to the tree line in semi-arid India. They found yield reductions of over 30% for crops growing at a distance of less than 10 m from the tree line.

Jha (1995) argued that the belief that eucalypts cause drying of the sub-soil and receding of the watertable is mistaken, and that eucalypt hybrids are efficient users of water compared to other tree species. Nantiyal (1994) concluded that eucalypts consume less water per unit of biomass weight produced than most species, but the total amount of water consumed by eucalypts is greater.

Eucalypts with a plentiful water supply grow exceptionally quickly, with growth rate generally correlated with transpiration (Evans 1992). Consequently, in agroforestry systems there is a trade-off between the superior growth rates of eucalypts, compared to those of many other trees species, and reduced crop yields. If this is taken into account then many potential conflicts should not arise.

Allelopathy of Australian tree species

Allelopathy refers to a plant's biochemical interactions with another plant which have detrimental effects on the growth of the second plant. Suresh and Rai (1987) reported on effects on sorghum, cowpea and sunflower of blue gum (*E. tereticornis*) and *Casuarina equisetifolia*. This impact is further supported by Poore and Fries (1985) (cited in Nair and Muschler 1993) who discussed evidence that *Eucalyptus* spp. produce toxins which inhibit growth and decrease yields of crops interplanted with them. In Thailand, *E. camaldulensis* is suspected of allelopathic effects on groundnuts (Watanabe 1992).

Allelochemicals are present in practically all plant tissues, including leaves, flowers, fruit, stems, roots, rhizomes and seeds (Nair and Muschler 1993). Some Australian species for which allelopathy can be demonstrated are listed in Table 1. It should be noted that demonstrated alleleopathy effects also exist for many commonly used non-Australian agroforestry species.

Nutrient competition of trees with crops

Trees are generally thought to be able to extract nutrients from deeper in the soil profile than crops. However, Halle et al. (1978) argued that this assumption is based on little quantitative information and that a number of studies have suggested that most tropical tree species have their highest concentration of roots in the uppermost soil horizon.

Various tree species exhibit varying degrees of root competition with crops. Researchers at the University of Agricultural Science (Bijapur, Karnataka, India), in a trial of six tree species with safflower, found they could be placed in the following order with regard to competition with crops: *Acacia nilotica* < *Acacia catechu* < *Eucalyptus camaldulensis* < *Dalbergia sissoo* < *Leucaena leucocephala* < *Casuarina equisetifolia*.

Ong et al. (1999) reported *Grevillea robusta* to have one of the least competitive root systems when compared to *Gliricidia sepium*, *Melia volkensii*, *Senna spectabilis* and *Cassia spectabilis*. Huxley et al. (1994) found, in an experiment with *G. robusta* and maize, that the roots of unpruned *G. robusta* extended at least 16 m x 16 m, but where the hedges where cropped this extension was only 4 m x 4 m. The upper 1.3 m of the soil profile was shared by maize and *Grevillea* roots, but the *Grevillea* root system extended down deeper than 2 m.

7. Concluding comments

Agroforestry holds considerable potential as a major land management alternative for producing wood, conserving the soil and maintaining the productivity of the land. ACIAR Projects 92/08 and 96/110 have demonstrated that some introduced Australian tree species can produce spectacular growth in the Philippines, even on the most difficult sites with degraded, thin alkaline soils. However, the ACIAR trails have not examined the performance of agroforestry systems incorporating Australian tree species. The research reviewed in this report suggests that there is potentially a role for Australian species in alley cropping and other agroforestry systems in the Philippines. The most promising species would appear to be *Casuarina equisetifolia*, *Grevillea robusta*, *Acacia mangium*, *A. auriculiformis*, *Eucalyptus camaldulensis* and *E. grandis*.

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Appendix A

Notes on specific Australian tree species

The following notes provide a brief description of the growth characteristics and timber uses of some of the more widely grown Australian timber species which have potential for agroforestry.

Acacia auriculiformis

This is a fast-growing nitrogen-fixing tree species. It grows in tropical lowlands and can tolerate a variety of soils, including infertile, clay, salt-affected and seasonally waterlogged soils. On favourable sites the tree can reach a height of 25–30 m with a long bole. However, trees are mostly 8–20 m high, multi-stemmed and crooked. The species is found in areas with a maximum temperature of 32–34°C and a minimum of 17–22°C, but can tolerate temperatures down to 8–10°C. There are reports of this species growing well on sandy soils in Vietnam where the mean annual rainfall is only 800 mm. *A. auriculiformis* can grow on acid sulphate soils (Nghia 1996). It is one of the few tree species which can be widely planted for fuelwood, construction wood and raw material for pulp production (Nghia 1996). It yields excellent-quality fuelwood (calorific value 4800–4900 kcal/kg) and charcoal, as well as high-quality pulp (Jha 1995). The wood is suitable for quality furniture manufacture.

Acacia mangium

This is a fast-growing nitrogen-fixing tree species, which grows to a medium to large tree (20–30 m). In trials in northern Vietnam, *A. mangium* achieved growth rates of 2 m/yr in height and 2.5 cm/yr in diameter. In natural distribution areas, the mean rainfall ranges from 1500 to 3000 mm. *A. mangium* requires more fertile soil, higher rainfall and less variation in temperature than *A. auriculiformis.* It can grow quickly on acid sulphate soils. Throughout the Philippines there are many cases of *A. mangium* displaying yellow leaves, with chemical analysis of the leaves revealing several nutrient deficiencies (ACIAR 1998). This problem has been overcome with fertiliser application. *A. mangium* has been widely planted in south-east Asia (Nghia 1996). The Malaysian Compensatory Planting Project has planted 47 000 ha of mainly *A. mangium*. Evidence has emerged from this project that *A. mangium* is valuable for reclaiming degraded land and as a source of small-diameter timber, but that its potential for sawn timber has been overrated (Brown et al. 1997).

Casuarina equisetifolia

This is a medium to large tree growing up to 30 m tall. The species is useful for sand stabilisation (Jha 1995) and improvement of the physical and chemical properties of sandy soils (by leaf litter and *Frankia* in the root nodules), and for alley cropping (Nghia 1996). It can also grow well in low-rainfall (700–800mm) areas (Nghia 1996). It can grow on mildly acidic to alkaline and saline soils (Binkley and Giardina 1997). This species produces excellent firewood on account of easy splitting and easy combustibility even when green. It produces little ash when burnt and has a high calorific value (4950 kcal/kg). It is also used as poles and posts, but is not well suited for timber (because of warping and splitting on drying) or pulp (from difficulty in grinding).

Eucalyptus camaldulensis

This species can grow well on infertile sandy soils in areas that receive a mean annual rainfall as low as 600 mm (Nghia 1996); however, the growth rate is greater in areas of high rainfall and high site quality (Swe 1996). It is one of the few species which can tolerate prolonged flooding (Evans 1992), and hence is ideal for planting along rivers or for incorporation into rice paddy fields. In Thailand, *E. camaldulensis* is commonly intercropped with cassava (Evans 1992).

Eucalyptus grandis

This is a large, fast-growing species reaching heights up to 75 m. It generally grows rapidly on good sites in sub-tropical and warm temperate climates. This species is probably the most widely planted eucalypt for wood production. Trials in south-east Asia indicate that *E. grandis* does not grow well on lowland sites (Nghia 1996).

Grevillea robusta

This species is commonly used in the East African highlands as a 'farm tree' (Evans 1992), dispersed through cultivated land to provide fuel, poles and fodder and to enrich the soil and provide a more favourable microclimate. A common example of intercropping in the African highlands is *G. robusta* with maize or beans.

Chapter 12

Some Observations on Timber Marketing in the Philippines

S.R. Harrison and J.L. Herbohn

Moderately well-established and efficient timber markets exist throughout the Philippines, due to the recent large-scale logging history and widespread use of cocolumber. Large timber companies work with roving purchasers who assemble supplies from large- and small-scale growers over a large area. Barangay lumber merchants purchase much of their timber directly from farmers, working on small price markups and selling timber for building construction, furniture and other purposes. The markets are familiar with a range of traditional (native and exotic) species, small logs and immature timber. Some difficulties could arise in the acceptance of new timber species, including eucalypts, for lumber, particularly if immature timber lacked stability, although shortage of timber for other uses such as poles, pulpwood and fuelwood should ensure market access.

1. Introduction

The success of Australian tree species in the Philippines will depend not only on their growth and yield performance but also on their acceptance in timber markets. This chapter discusses timber markets in the Philippines, and examines the market prospects of Australian tree species. Much of the information presented here derives from personal observation and discussions with researchers, timber merchants, and manufacturers of furniture and joinery product in the Philippines. To some extent, the comments represent subjective views of the authors. They are necessarily based on visits to a relatively small number of sites in the Philippines, together with inferences from other countries.

This chapter first reviews general issues in timber supply and demand, and then examines the various sectors of the timber market. Some observations are made about the purchase practices of large timber firms. Finally, comments are made about the current and potential uses for, and limitations of, Australian species.

2. Timber producers and purchasers

Timber producers in the Philippines may be grouped as government and industrial foresters, farm forestry and community based forest management. Historically, the Philippines was a major timber exporter, with large volumes of native species harvested under timber licence agreements and sold in both local and overseas markets. Bans have been imposed on logging of the remaining old-growth forests and residual forests on land of 18% or greater slope and above 1000 m in elevation (Sy 1998, p. 11). The Philippines Government banned log exports in 1986 and timber exports in 1989. Logging of native forests has all but ceased, with substantial timber imports now taking place. The net shortage of timber has led to a rapid increase in timber prices (Garrity and Mercado 1994, cited in Magcale-Macandog et al. 1998), and provided a stimulus for local production. As discussed in previous chapters, a variety of species of timber trees are grown in the Philippines; these include conifers, gmelina (*Gmelina arborea*), falcata or albizia (*Paraserianthes falcataria*), bagras (*Eucalyptus deglupta*), mahogany (*Swietenia macrophylla*), teak (*Tectona grandis*) and some eucalypts and acacias (including *Acacia mangium*). Rattan is also widely grown. Cocolumber is used ubiquitously in the Philippines as a multi-purpose timber. Fruit trees, such as mango and citrus, also make a contribution to wood supplies.

Timber is needed for a variety of purposes, including industrial products (plywood, panelling, composite wood products, newsprint), construction, furniture, woodcrafts, poles (electricity, phone, house), stakes, forklift crates, fuelwood and charcoal.

The large industrial timber-processing companies are a major market for timber, from both large-scale and small producers. Also, with a large and growing population, the Philippines has a high demand for housing construction and for furniture. Furniture manufacturers and retailers (often the same firms) are a common site in *barangays* (villages), *bayans* (towns) and cities. Traditional species favoured for furniture include the prized native timber narra and mahogany. Gmelina is used extensively for furniture, due to availability and ease of working, but mainly in lower-priced products. There is a long history of wood crafts in the Philippines, and highly skilled artisans still produce outstanding furniture and wood carvings using, in particular, narra and mahogany.

There is considerable demand for large poles – for electricity transmission lines and telecommunications – by government, and for smaller poles for dwelling construction in the private sector. Concrete poles are widely used, supported by abundant supplies of limestone (particularly on Cebu) and sand. There is great scope for further construction of power and telephone lines and hence demand for large poles.

While there is little need for home heating in the Philippines, fuelwood is in high demand for cooking. There is considerable demand for charcoal, particularly from restaurants but also for some industrial uses and as domestic fuel. The high demand for timber and the ability of markets to handle small logs, immature timber and, in general, timber of mediocre quality mean that little product is wasted.

3. Timber marketing by government and industrial foresters

A variety of species are grown in government plantations. Bukidnon Forest Industries in Mindanao (now being privatised), has developed 7000 ha of *A. mangium*, *E. deglupta*, *Pinus caribaea*, *E. camaldulensis* and other species (Sy 1998, pp. 10–11). The Philippine Forestry Development Project in Ilocos Norte (FRDPIN), Luzon, has established 13 000 ha of *E. camaldulensis* and other species (Sy 1998). To date, little of this timber has been harvested.

Among the industrial foresters, PICOP Resources Incorporated (PRI) has established more than 40 000 ha of *Paraserianthes falcataria*, *E. deglupta*, *A. mangium* and other species for its sawmills and pulp and paper mills. The Nasipit Lumber Company (NALCO) has more than 4000 ha of the same species, while Provident Tree Farms Incorporated (PTFI) has about 6000 ha of *A. mangium*, *G. arborea* and *Endospermum peltatum* (Sy 1998). The main species in the plantations of Alcantra and Sons (Alsons) is *E. deglupta*, with some gmelina; *A. mangium* has been planted since 1990, but has not performed well. These industrial foresters are all located in Mindanao.

A planned project also in Mindanao is the Caraga Timber Corridor Development Program, under which there are plans to develop a 120 000 ha plantation of tropical hardwoods on deforested land and a pulp mill with 50 000 tons/year capacity (Arias 1999). Joint venture investors from New Zealand and Taiwan are to participate in this huge project (Crismundo 1999).

From the above, it is apparent that large-scale foresters are sometimes vertically integrated and hence are the main consumers of their own timber output. Where this is not the case, they can be expected to form alliances with larger industrial customers or larger lumber merchants, while selling (mainly poorer quality) timber and fuelwood to local markets. Thus, for example, PRI supplies caribbean pine to Consolidated Plywood Industries in Davao City.

4. Timber marketing by small-scale producers

Evidence from various sources suggests that small-scale producers (particularly farmers) mainly grow timber for their own use. Farm forestry has been operating at a sufficient scale for long enough for marketing behaviour to be observed. A survey of farm forestry in Claveria in northern Mindanao revealed that 'the prime objective of most farmers who planted *Gmelina* trees (88%) was for future housing needs of their families. About 41% of the farmers indicated that they planted *Gmelina* for additional income for their children's education; to buy appliances, farm equipment like a brushcutter; and for other financial needs' (Magcale-Macandog et al. 1998, p. 80).

Moderately well-established and efficient timber markets exist throughout the Philippines, due to the widespread use of cocolumber, and in some areas the extensive recent logging activity. Shortage of timber and high interest rates have led to use of small logs from young fast-grown trees, typically of 8 to 15 years in age. In the town of Malaybalay, nine lumber merchants were observed to operate. A number of these lumber yards were visited by the authors. Sometimes timber is delivered by farmers, as roundlogs or cut into flitches or planks by chainsaw or bandsaw. Farmers cart logs to the nearest road with draught animals, and hire a vehicle such as a jeepney for transport to a lumber yard. In other cases, employees of lumber merchants go to farms and cut trees to flitches by chainsaw. Further sawing on small bench circular saws and planing is carried out at the lumber yard. Employees are paid 1000 pesos per month (about $1.60/day) plus accommodation and food.

Retail timber prices are about P14/bdft (board foot), against a buy-in price of P11/bdft[1]. *Gmelina* is purchased at 8–10 years old, and is of mediocre quality, sometimes bending on cutting. Board widths are 6 (mostly), 8 and 10 inches, and length typically 8 ft. Mahogany is slightly more expensive, retailing at P18/bdft, with a buy-in price of P15/bdft. The largest customers are building contractors. Some of the lumber yards produce window frames and sashes. They also deal in plywood and panelling obtained from industrial forestry companies. Demand for timber exhibits some seasonal variation, being greatest in the dry period when most construction takes place.

Cocolumber is an important component of farm forestry, with mature coconut trees (over 50 years of age) providing a highly versatile and popular timber used for house framing, furniture and poles. Lumber merchants obtain cocolumber for about P6/bdft from the coastal provinces, and it is sold for P7/bdft. The Philippines Coconut Authority has introduced a permit requirement for felling of coconut trees in an attempt to reduce loss of coconut plantations.

As well as local timber merchants, industrial timber processors provide a market for timber from small-scale growers with roving purchasers (middlemen) assembling lots for timber companies.

[1] A board foot is equivalent to a one foot (30 cm) length of 4 x 3 inch or 6 x 2 inch timber (1 inch = 2.54 cm)

Farmers must obtain permission before harvesting trees – from the *barangay* captain (for small numbers of trees only) or from the Community Environment and Natural Resources Officer (CENRO) of the Department of Natural Resources and Environment (DENR). As noted by Magcale-Macandog et al. (1998), a recommendation letter from the mayor and a land tax declaration are needed to obtain permission from the CENRO to fell trees, and a transport permit is required from the barangay captain.

Long-distance road transport of timber presents major difficulties for small-scale producers. Considerable time can be required to obtain permits; trucks pass a number of checkpoints and repeated charges may be levied. It was commented that a truck may have to pass 40 checkpoints – imposed by the DENR, LGOs, the military, environmental NGOs and church groups – with a total charge of P5000 . Stories were encountered of farmers making valuable timber into charcoal to avoid transport charges and other obstacles. While farmer cooperatives are common in the Philippines, often consisting of hundreds of members, these have not been active in timber marketing.

The domestic fuelwood market operates largely outside the lumber market, and involves collection of bundles of prunings, thinnings and branches of harvested trees by small-scale operators. These are often transported by draught animals. They may be stacked on the roadside for sale to passing traffic. Pasicolan and Tracey (1998) noted cases where fuelwood gathering provides the main livelihood of farmers in Cagayan province. Magcale-Macandog et al. (1998) noted that farmers sell pruned gmelina branches, bark and sawdust as bakery and domestic fuelwood and even sell dried and bagged falcata leaves as organic fertiliser.

5. Marketing strategies in community based forest management

The development of community forestry programs under the community based forest management (CBFM) arrangements is relatively new, so it is difficult to observe marketing strategies. CBFM includes a number of community and social forestry programs. One of its components is the Certificate of Stewardship arrangement under which squatters may obtain title to rural land provided they devote 20% of the land to forestry. This is more in the way of farm forestry than common property forestry, and marketing will be along the lines of that for farm forestry. Fruit trees, with some residual timber value, will probably form a major enterprise on these landholdings.

Community forestry groups sometimes have more than 100 members, all contributing labour to common property forest resources. Here, it is to be expected that assistance in marketing will be provided by the DENR and by NGOs. Timber sales will require approval by the DENR, which may hold an equity in the timber produced. The group members themselves will provide a market for forest products. Discussions by the authors with the Alcoy community group in Cebu revealed that early prunings and thinnings were distributed to group members, e.g. for stakes and fuelwood. However, it was clear that the group aims to market timber as a revenue-earning activity. Also, there are plans for value adding by the community, initially at a relatively simple level – e.g. production of joinery components such as railing banisters, for local sale and export. This will require training of community members in furniture-making skills, and purchase of appropriate equipment.

6. Timber purchasing by large merchants and timber processors

A visit was made to a large sawmill and lumber trading company in Cagayan de Oro, Mindanao. Both locally-grown and imported timber are used, and in collaboration with its other plant sites the company produces a variety of outputs including power poles, flooring, lamiplank, finger-jointed planks, flooring, doors and windows. Timber species used include gmelina, falcata, eucalypts, mangium and others. Timber is sourced from up to 400 km from the coast; beyond that distance transport costs mean purchase is not warranted. Inexpensive supplies of falcata are available, but not enough gmelina can be obtained to meet demand. Timber purchases are from local middlemen, timber companies and government. The firm imports radiata pine from New Zealand, Chile and South Africa. Product sales are made to both local and overseas markets; falcata is sold to Taiwan, gmelina to England and hardwood flooring to Canada. A role for eucalypts for house framing and finger-jointing was identified. An acquisition price of P3400/m^3 was paid for short-length gmelina, and P5400/m^3 for round logs including mahogany from government land. It was observed that timber demand is declining due to the availability of substitutes. The view was expressed that ancestral domain land claims will reduce production from large-scale plantations; hence small-scale producers will become the main domestic timber source in the future.

At the Alsons Econowood Plywood factory in Davao City, which produces 18 500 plywood sheets a day, the furnace uses fuelwood and bunker oil in an 80% : 20% mixture. Eighty to 100 tonnes of fuelwood (mostly *Leucaena* at the time of visit) per day are used, at a cost of about 400 pesos per tonne. Logs were previously obtained from Africa and Malaysia, and are now obtained from New Zealand. The company has a policy not to use logs from natural forest. Alsons were heavily into exporting, to the UK, but in the last few years decided to concentrate on supplying the Philippines plywood market; their product dominates in Mindanao.

Consolidated Plywood Industries in Davao City produces timber components such as dowelling and flooring rather than finished furniture, and concentrates on export markets. The main markets are Japan (taking 60% of products) and the USA (20%), with smaller quantities sold to Australia, Korea, Taiwan and the domestic market. Timber species used include mangium, gmelina, falcata, bagras and caribbean pine sourced locally, and imported *E. saligna* and *E. botryoides*.

7. Market prospects for Australian tree species

The challenge for timber of Australian tree species, particularly eucalypts and acacias, is to gain a foothold in the market as a new product. In some locations, mangium, *E. camaldulensis* and possibly other Australian species have gained recognition. But where they are being newly trialled, purchasers will naturally be cautious about timber properties. There is some evidence that timbers of Australian tree species are attracting lower prices, simply because they do not have market recognition.

The timber properties of eucalypts and acacias will differ from those of traditional tree species. Gmelina is a particularly stable species, in the sense of not readily warping, twisting or cracking. The same cannot be said for eucalypt timber, especially when rapidly grown and harvested at an early age. While *barangay* timber markets are moderately tolerant of low-quality product, additional curing measures may be required if short-rotation eucalypt timber is to be used for lumber – and these measures generally are not adopted at present in *barangay* timber processing systems. There could, for example, be a need to set up kiln drying, which would impose considerable cost. Even when kiln drying equipment is available, some difficulty can be experienced with eucalypt timber for particular purposes. In this respect, Wee (1999) noted difficulty with using a shipment of *E. saligna* from New Zealand for production of flooring.

The need for suitable timber properties has implications for choice of eucalypt species, since there is considerable inter-species variation in timber characteristics. In Australia, eucalypts and acacias have recently been used for furniture and fittings. For example, Tasmanian oak (*E. regnans* and other similar species) and Tasmanian blackwood (*Acacia melanoxylon*) – which are species not confined to the colder areas – are used commercially for kitchen fittings. Highly attractive furniture has been produced from mangium in north Queensland, and from various eucalypts, although the timber is heavier (and hence the furniture needs to be thinner) than traditional furniture species.

Timber stability is less of an issue when eucalypt or acacia timber is used for poles or fuelwood. Large areas in the Philippines are not served with a telephone or electricity distribution network. Further electrification and extension of the telecommunications network, and routine replacement of poles, could lead to a large increase in demand for eucalypt poles. Bagras (*E. deglupta*) is widely used for poles. Also, gmelina is used for 'electric poles' and falcata for shorter poles (Magcale-Macandog et al. 1998). Some of the Australian eucalypts now being trialled in the Philippines are probably more suitable than these species in terms of growth rates and timber properties, and with plantations more resistant to wildfire. In Australia, *E. pellita* (performing well in trials in Mindanao) is not regarded as a favourable pole species, though *E. cloeziana* (not being trialled in the Philippines) is in the top strength category for poles[2]. It could be that mobile phone technology will supersede the need for ground lines – also, electricity could displace fuelwood as an energy source for cooking – but this is unlikely to happen quickly.

Eucalypt timber is well regarded for pulp for paper making, and has potential for industrial uses such as production of composite wood products and rayon and other fabrics. Also, trials in Queensland have revealed that various eucalypt species can be made into attractive wood panelling, with prominent grain features. In India, very large scale industrial use of eucalypt timber for newsprint and rayon production was an important reason for the extremely large plantings. Also, our observations suggest that large amounts of eucalypt timber are used as industrial fuelwood, e.g. for furnaces and boilers. A limitation is this regard is that fuelwood is a low-priced product and, due to transport costs, it would need to be produced near the use site.

A negative feature of eucalypts and acacias is that they do not produce non-timber forest products (or minor forest products) which farmers and tribal people can consume or sell for cash. However, this limitation applies also to traditional timber species in the Philippines – a minor exception being sale of seeds, particularly from gmelina trees.

Amongst other Australian species, *Grevillea robusta* has excellent timber quality while *Casuarina* species are useful fuelwood species. So, should these species be grown to any extent, marketing will not be a limitation on their suitability.

[2] A lower strength category means that larger-diameter poles must be used, which increases the rotation length.

8. Summary

Due to the earlier abundant log supplies, continued legal (and probably some illegal) logging and widespread use of cocolumber, timber marketing chains are an established tradition in the Philippines. The marketing system for small-scale forestry appears quite efficient, with relatively low margins and little timber wastage. Some plantations of Australian species have been established, though these have been mainly in industrial forestry, and to date limited harvesting has taken place – hence these species in general still have a market recognition problem in towns and villages. Given that farmers use most of the timber they produce, that industrial forestry in general has had limited success, and that the Philippines has a high population and household formation rate and hence a high demand for dwellings, it is likely that there will be timber shortages and reliance on imports. Severe timber shortage should lead to effective demand for all timber types. While rapidly grown short-rotation eucalypts may encounter some difficulties in lumber product applications, they have considerable potential for a range of purposes including construction, furniture, poles, industrial uses and fuelwood.

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Chapter 13

Perceived Problems and Potential Role for Eucalypts in Farm Forestry: Observations from East India

S.R. Harrison and K.C. Roy

Australian eucalypts are suitable for a wide variety of climatic conditions and soil types, and provide a fast-growing source of timber for industrial and housing use in developing countries. The extent of adoption in some developing countries has been spectacular. However, criticisms have been made concerning the social desirability of large-scale growing of eucalypts, and ecological impacts related to soil hydrology, land degradation and impact on nearby crops. In some locations in India and Thailand eucalypts have been viewed with indifference or hostility by local communities, and have been referred to as 'the tree that causes riots'. Negative attitudes often stem from adverse impacts of reforestation on access to common property land, and it is difficult to disentangle fact and fiction with regard to criticisms of eucalypts vis-à-vis other species. Eucalypts are seen to have an important and continuing role for industrial, farm and village forestry in east India, and experiences there have important implications for other countries where eucalypts are currently being trialled, such as the Philippines.

1. Introduction

Trees of the *Eucalyptus* genus, mostly native to Australia, have been grown widely overseas. A large number of eucalypt species are grown commercially, the more popular including *E. camaldulensis* (river red gum), *E. tereticornis* and hybrids. Richardson (1988) reports that: '[i]n Brazil alone, more than two billion eucalyptus trees have been planted. In China's arid Sichuan Province, 500 million of the trees provide timber and shade in reforested areas'. Australian eucalypts have also been widely planted in the Thailand, India, Spain and the USA.

It is generally considered that eucalypts have been highly successful overseas, in a short rotation (5–10 years) as a source of industrial input and domestic fuelwood. However, a surprising amount of criticism has arisen over large-scale plantings of eucalypts in developing countries, and in some cases the rate of adoption has been slow. For example, adoption of Australian tree species – in particular, eucalypts and acacias – in the Philippines has been unexpectedly low and faces a variety of constraints (Harrison and Herbohn 1999; Venn 1999). Two of the more successful eucalypt species, *E. deglupta* and *E. urophylla*, are in fact of Filipino and Indonesian origin respectively.

The progress of eucalypts in India has followed a fascinating pattern – from very high adoption in the 1980s, to severe hostility by rural communities, to a more stable recent role. Eucalypts were a key species in social forestry initiatives when these had their genesis in India.

Rapid adoption as a commercial crop occurred in a number of states, particularly in the fertile north-west, in the late 1970s and early 1980s. 'Between 1981 and 1988, farmers in India were reported to have planted around 8.6 *billion* trees on private land. Many of the planting programs... were financed by the government, particularly with assistance from the World Bank, and from Canadian and Swedish donor agencies. The speed with which rural households adopted trees, primarily *Eucalyptus* hybrids, into their farming system, was truly phenomenal by any standard. The total newly planted area has been estimated to cover around 2.5 million ha. Most of these new trees were planted either in woodlots or around field bunds.' (Dewees and Saxena 1997, p. 219). Trees were regarded as being more drought-resistant and having less price variability than crops, and the lower labour intensity of forestry freed labour for wage-earning activities.

Strong criticism of social forestry arose in the later 1980s, on both social and ecological grounds. Social forestry met with mixed success. Most planting was undertaken by large farmers and absentee landowners, who could afford the initial outlays and the wait for returns (typically about 6 years for poles). Also, planting was dominated by upper-caste farmers, who 'are generally better educated and have more relations and friends in the bureaucracy. This gave them better access to seedlings, markets and extension advice.' (Dewees and Saxena 1997, p. 260). Timber was directed to markets rather than to the needs of the poor, and pressure on native forests continued. There was limited planting on degraded land. Dewees and Saxena (1997) noted that the supply of poles, fuelwood and pulpwood exceeded the market demand, leading to a price collapse. A contributing factor was subsidised timber from state forest departments. Aggravating the impact of the price fall were the effects of trees on yields of adjoining crops, lack of marketing infrastructure and government subsidies relative to crops, and perhaps exploitation by market intermediaries. Eucalypts fell out of favour and in some cases plantations were uprooted.

According to TWN (1988, p. 624), 'In recent months and years, there have been serious scientific critiques on the large-scale planting of eucalypt trees in Third World countries. This eucalypt planting is a major component of the so-called "Social Forestry" projects that are supposed to improve social welfare and the environment. In reality, they have caused disastrous impact on the environment and adversely affected the water, soil and agricultural activities of surrounding poor communities. This has led to protests by farmers in Thailand and India.'

The situation for eucalypts is, relatively, more favourable in West Bengal where land is typically less suitable for cropping and wood product markets have been stable. This chapter examines the problems and prospects for eucalypts for small-scale forestry in rural and tribal areas in east India, drawing on observations from a recent visit to West Bengal and Orissa. The favourable features of these species and the perceived negative impacts are examined.

2. Favourable features of eucalypts

The properties of eucalypts have led to their widespread adoption in developing countries. Eucalypts are, in general, rapidly growing species, which allows large quantities of timber biomass to be produced quickly and reduces the inputs required for weed control. A large number of eucalypt species are available to suit a wide variety of climates and soil types – including lower-rainfall areas (1000 mm or less), and low-fertility and poorly drained soils. This allows them to be grown in areas where other species will not thrive. They typically have good form, and a length suitable for poles. Some of the species are relatively resistant to fire damage. In general, they coppice well.

3. Problems with eucalypts in farm and village forestry in east India

A number of impediments exist with respect to small-scale forestry in general in east India. Very small holdings, the crucial need to produce food crops, lack of finance, and the requirement for a short payback period are obvious impediments. Risk of theft and vandalism reduces the attractiveness of forestry. Various additional impediments affect the production of commercial timber, e.g. difficulty in obtaining harvesting and transport permits (Molnar et al. 1995, p. 85). Of greater relevance here, a number of specific drawbacks or negative attitudes with respect to eucalypt species may be identified, as listed in Table 1.

Loss of common property resources

As mentioned above, a frequent motivation for protests against eucalypt plantations is loss of common property resources. These resources include village commons, and government reserves which squatters have occupied for a number of years and over which they have gained some real or presumed property rights.

Lack of non-timber forest products

One of the major criticisms of eucalypt plantations is the lack of edible and other non-wood products. Farmers and tribal people in India favour multiple-use tree species; the latter, in particular, rely heavily on non-timber forest products such as fruit, berries, leaves and medicines. TWN (1988) noted that large areas of natural forests in Karnataka, India, which have provided basic material needs for villagers have been cleared to establish eucalypt plantations. They noted, for example, that cattle cannot browse on eucalypt leaves. Similarly, Hardiman (1996) observed that eucalypts generate few non-timber benefits.

Greater availability to large farmers

Farmers with larger holdings have greater opportunity to grow eucalypts, and it is sometimes believed that tree planting by large farmers will affect crops on smaller neighbouring holdings and force other farmers to sell land.

Table 1: Drawbacks and negative attitudes concerning eucalypt species in India

Drawback or issue	Example
Social issues	Loss of common property resources
	Loss of non-timber forest products
	Greater availability to large farmers
Biodiversity loss	Poorer habitat for wildlife and native plant species
Timber characteristics	Timber instability relative to some traditional species
Market limitations	Lack of established market for eucalypt timber
Hydrology issues	Excessive water use, reduced groundwater recharge
Soil condition issues	High nutrient demands, erosion, desertification
Incompatibility with surrounding land use	Toxicity of root and leaf exudates (allelopathy). Unsuitability for agroforestry
Other impediments with eucalypts	Lack of seedlings, tapering of growth after early progress, susceptibility to pests

Limitations of timber properties

When growing trees for lumber in short rotations, some difficulties can arise with respect to timber properties of eucalypts. Relative to traditional species such as gmelina, immature eucalypt timber is inclined to bow, warp or split if not handled carefully. However, this is generally not a problem for industrial timber, poles and fuelwood.

Lack of markets for eucalypts

Non-traditional species typically are at a disadvantage with regard to consumer recognition and established market outlets. Where eucalypts are introduced into new areas, lack of product recognition and established markets could lead to lower timber prices relative to traditional species. For example, Contreras-Hermosilla (1995, pp. 66–68) noted that 'eucalyptus was introduced by the government of Rajasthan where there were no markets for eucalyptus wood – no paper mill or other large buyer of eucalyptus – and where poles are generally imported from Haryana. Small farmers therefore found no buyers for their trees.'

Excessive use of water

TWN argue that when eucalypts are grown in low rainfall areas 'the vast network of roots just below the soil surface extracts every bit of moisture from the soil' (p. 625), which results in 'drying up of streams' and 'causes wells to dry up' (p. 624), and has the effect of 'depriving surrounding communities of water for domestic and agricultural use' (p. 625). Jha and Sarma (1994) noted that the main criticism against eucalypts is their high water use. They went on to refute this criticism, noting that studies in Israel indicate that evapotranspiration from *E. camaldulensis* is only slightly higher than evaporation from bare land. Table 2 reports water consumption rates of eucalypts (probably *E. tereticornis*) and several indigenous or common species in India, obtained from trial work at the Uttar Pradesh Forest Department over the period 1982 to 1993. Amongst the species trialled, eucalypts had the greatest water efficiency.

It would appear that eucalypts are highly efficient at extracting water from the soil, which allows them to grow in relatively low rainfall areas, but are not inefficient in converting water into timber.

Table 2: Water consumption of eucalypts and some other species

Species	Water use efficiency (litres/gram biomass)
Acacia auriculiformis[1]	0.72
Albizia lebbeck[1]	0.55
Dalbergia sissoo[1]	0.77
Eucalyptus hybrid[1]	0.48
Derris indica[1]	0.88
Paraserianthes falcataria[2]	1.23
Pongaruia pinncita[3]	1.30
Syzigium cerminci[1]	0.50

Source: 1. Jha and Sarma (1994, p. 104); 2. Singh et al. (1991), reported by Venn (1999, p. 112); 3. Chaturvedi (1987), reported by Venn (1999, p. 112).

Inhibited groundwater recharge

TWN (1988) state that eucalypts inhibit recharge of groundwater, presumably due to drying, reduced cover and reduced infiltration of surface soil. They argue that this is a particular problem in areas with an annual rainfall of less than 1000 mm.

Depletion of soil nutrients

According to TWN (1988, p. 625), '[t]he nutrient requirement of eucalypts for fast growth is very high... [and] it returns a very small quantity of nutrients to the soil through leaf litter, causing the soil to lose its nutrients in the long run'. However, evidence indicates that eucalypts are relatively efficient in their consumption of nutrients per unit of biomass produced, ranking above *Tectona grandis*, *Shorea robusta* and *Pinus roxburghii* in India (Shah 1988, cited in Venn 1999). Florence (1986) noted that nutrient withdrawal may be rapid for short-rotation eucalypts, but nevertheless in unlikely to exceed that of other fast-growing species.

Eucalypts as a cause of soil erosion

According to Poopat (1988, reproduced in TWN 1988, p. 633), '[i]n wet conditions, eucalyptus trees do little damage to ground cover. But in dry conditions, eucalyptus draws most of the water, and ground herbs die, leaving the soil bare and prone to erosion.'

Allelopathy and adverse effects on cropping

There is a belief among many rural communities in developing countries that eucalypts inhibit the germination and growth of crops or other trees by producing toxic foliar or root exudates. It is also said that, where a eucalypt crop is harvested and replaced by an agricultural crop, that crop will not thrive – at least for several years (TWN 1988). Venn reported information from surveys in Kenya and India that eucalypts affected nearby crops. Saxena (1992) noted crop effects up to 10 m from the tree line. According to TWN (1988, p. 625), 'farmers surrounded by eucalypt plantations had to dig trenches to protect their food crops'. They also asserted (p. 625) that eucalypts are 'toxic to soil organisms such as earthworms which are responsible for building soil fertility and improving soil structure'. The scientific basis for concern over allelopathy is still uncertain (Shah 1988 and Florence 1996, as reported by Venn 1999). It is likely that traditional species also adversely affect growth of vegetation in close proximity. Also, a more obvious explanation for poor performance of other vegetation growing close to eucalypts is the high ability of this genus to extract water and nutrients from the soil, which is the reason why it often outperforms other tree types in marginal locations.

Unsuitability for agroforestry

Agroforestry is widely advocated for small-scale farming in developing countries as an efficient land use for production of food crops and timber. As eucalypts are evergreen and tall, they shade alley crops. Also, their long root system and high efficiency in water and nutrient extraction mean that other crops cannot be grown in close proximity.

Reduction in biodiversity

TWN (1988) argued that large areas of dense eucalypt plantations are poor habitat for indigenous animals and plants, noting adverse impacts on villagers in Brazil.

Increased threat of desertification

TWN (1988) argued that the combined effect of the high use of water and nutrients and suppression of other plants increases the risk of desertification, loss of production and employment, and forced migration to urban centres.

Early tapering off in growth rates

Extension literature in the Philippines suggests that, while eucalypts have high early growth rates, growth can taper off rapidly. This judgment appears to be based on limited information since most of the eucalypt trials in the Philippines were established in the last 5 years. This does not appear to be a major concern in India, where relatively widespread growth of eucalypts has been observed for about 20 years. It could be expected that growth rate will taper off on poor sites or under low silvicultural intensity (e.g. little thinning, which is common in farm forestry in the Philippines).

High susceptibility to pest damage

Another criticism levelled at exotic species in the Philippines (including eucalypts and acacias) is that they are prone to damage by insect pests such as wood borers. This also does not appear to be a prominent concern in India.

Lack of seedling availability

While this is recognised as a problem in some areas of the Philippines, the level of technology required to produce eucalypt seedlings is not high. Further, it is apparent that very large numbers of seedlings have been produced by forest services in India, although seedling quality may have sometimes been low.

4. Protest movements targeting eucalypt plantations

A number of public protests have taken place demonstrating against large-scale planting of eucalypts. Richardson (1988, reproduced in TWN 1988, p. 634) reports on an 'outbreak of ecological nationalism' arising from the large-scale planting of Australian eucalypts overseas. According to Poopat (1988), 'Eucalyptus is sometimes called "the tree that causes riots" because conflicting views over its merits have resulted in disputes in Thailand and abroad'.

Anon (1988, reproduced in TWN 1988, p. 629) reported that at Prachin Buri in Thailand '[a]bout 3500 villagers burnt down forestry officials' houses during a two-day rampage as part of the growing resistance by villagers against the government's eucalyptus planting policy... The villagers also set fire to a garage, two motorcycles, a home-made truck, four shelters, two greenhouses...' Three months earlier, at Burin Ram, there had been a demonstration of about 4000 people who set fire to a forestry department greenhouse and eucalypt trees. It would appear that in both cases government eucalypt planting had taken place on land previously used by farmers. The villagers at Prachin Buri apparently were upset because they were served notice to leave their land, which they illegally occupied in what used to be national forest reserves. '... they resent their eviction, especially when they see outsiders, who sometimes cooperate with foreign investors, move in to plant eucalyptus.' (Anon b 1988, reproduced in TWN 1988, p. 632)

In Karnataka state in southern India, where a large World Bank forestry program was undertaken, farmers marched on a nursery and uprooted all the seedlings (TWN 1988, Poopat 1988). 'There have been similar protests from villagers in other parts of India which have been planted with eucalyptus' (TWN 1988, p. 624).

It is probable that much of the hostility towards eucalypts in India arises from social factors rather than characteristics of eucalypt species. In particular, where eucalypts have been planted on what was previously common property land – particularly when native forests were cleared – it is not surprising that local communities who benefited from these resources would be resentful.

5. The role of eucalypts in east India

In general, eucalypts are not as highly regarded for lumber production as some other widely grown tropical timbers including mahogany (*Swietenia macrophylla*), teak (*Tectona grandis*) and gmelina (*Gmelina arborea*). However, the wide variety and versatility of eucalypt species led to them being favoured in social and farm forestry. High water and nutrient efficiency and a high ability to access water and nutrients when in limited supply mean they can be grown in wasteland and climatically marginal areas where there are few if any alternative profitable land uses.

What silvicultural systems for eucalypts are appropriate in east India? There is considerable large-scale production, which has run for about 20 years. Eucalypts have achieved success for industrial uses including production of woodchips for making plywood, paper and rayon, for poles for electricity transmission and telecommunications, and for industrial wood fuel and charcoal.

There is also considerable small-scale planting, although severe land scarcity pressures exist and the eucalypt area may be relatively stable now. Small-scale forestry in India is divided into eight classes: farm forestry, village woodlots, block plantations, road-, pond-, rail- and canal-side plantations, and others (collectively social and farm forestry) (MOEF 1998). Block plantations are defined as compact plantings of more than 0.1 ha on private or government land, while farm forestry includes patches of up to 0.1 ha on private land. At the farm and village level in India eucalypts are typically grown for own use, rather than sale, for lumber, poles, stays, roof framing and fuelwood.

Some possibilities for further plantings include: planting a mixture of species, including a small proportion of eucalypts; planting alternate row systems with early harvest of eucalypt rows; and using eucalypts in amelioration of poor soils, such as in land stabilisation, reduction of waterlogging and control of soil salinity. Molnar et al. (1995) noted that eucalypts are tolerant to poorer soils, and poorly drained and lower-rainfall areas.

6. Some observations on the role of eucalypts in West Bengal

Observations on the role of eucalypts were made during a visit to the Midnapur area of West Bengal in September 1999. The striking impression was the widespread presence of both government plantations and small-scale plantings. In the former, grazing rights were held by tribal villagers. Typically, very small-scale plantings were present on field boundaries and sides of roads and irrigation canals, as well as in small woodlots in tribal villages. Transport systems for timber for village use included head loading and pushbikes.

Eucalypts appeared to have little role in joint forest management, where sal trees provided leaves for plate making, which was a major source of income for some tribal villages.

Coppicing appeared to be widely practised in large plantations, providing a short-rotation source of small poles and fuelwood.

Another striking impression was the large log stacks of predominantly eucalypt timber at railway stations. These included some sawlogs but large quantities of small timber, presumably for industrial uses such as production of paper and fibreboard.

7. Discussion

Although eucalypts are widely grown in developing countries, in some cases they have been strongly criticised and have even led to violent protests. It is difficult to separate fact and myth concerning their suitability for small-scale forestry. The most severe criticisms have been in relation to large-scale plantings, and have concerned social as much as ecological factors. In West Bengal, use of eucalypts in both large and small-scale forestry has continued. It may be that the negative aspects are unimportant where loss of access to traditional land is not involved, and where moderate to high rainfall is received.

It is concluded that there is some justification for caution in use of eucalypts, although some of the criticisms are misplaced. Potential exists for planting eucalypts as a timber source on rural smallholdings – including land of tribal villages – particularly as roadside, canal-side and field border plantings. Since timber trees compete for scarce land with food crops and fruit trees, individual plantings are likely to involve quite small areas. In aggregate, however, a considerable additional area of farm forestry utilising eucalypt species could be planted.

The slow rate of adoption of eucalypts in the Philippines is associated with some of the same negative views of these species as reported in India. Given the relatively high rainfall levels in the Philippines, and control of sloping lands by the Department of Environment and Natural Resources, it would appear that eucalypts have the potential to play an important role in small-scale forestry.

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Chapter 14

Impediments to Adoption of Australian Tree Species in the Philippines

T.J. Venn, S.R. Harrison and J.L. Herbohn

The decision of industrial and farm plantation growers in the Philippines on whether to adopt Australian tree species is not made exclusively on potential yield and financial returns information. This chapter outlines the range of resource input, market, property rights and attitudinal impediments which may potentially influence their decisions, and expands upon the financial impediments introduced in Chapter 8. It is concluded that uncertainty of land tenure is an important impediment to tree growing in general. Lack of seedling supplies and negative attitudes to exotics impede adoption of Australian species.

1. Introduction

In developing countries, adoption of fast-growing timber species as a farm enterprise has the potential to provide the lumber and fuelwood needs of smallholders, and generate revenue. In addition to welfare gains, considerable environmental benefits may be achieved. Both supply of timber resources and environmental issues are important in the Philippines, where deforestation in recent decades has led to a shortage of timber, resulting in the unsustainable felling of coconut trees for timber.

Australian eucalypts, acacias, grevilleas, casuarinas and other species are grown widely around the world, particularly in tropical areas. Australian species are recognised as being capable of rapid growth, and as having high timber strength and other useful timber properties. Some species, especially *Eucalyptus camaldulensis* and *E. tereticornis*, are recognised as having high typhoon resistance, and many species have relatively high fire resistance. Several species also exhibit good form (e.g. for poles), with some having the desirable trait of being self-pruning. Australian species have been found suitable for a wide variety of sites, including wet sites and marginally low rainfall areas (particularly eucalypts), and sandy and salty sites (particularly casuarinas).

Observations on field trips to the Philippines and discussions with foresters suggest that Australian species are not widely grown in the Philippines. Yet there would appear to be considerable small-scale forestry, utilising species such as gmelina (*Gmelina arborea*), mahogany (*Swietenia macrophylla*) and bagras (*E. deglupta*). In addition to these species, industrial plantation operations grow falcata (*Paraserianthes falcataria*). Notably, of these species only bagras is native to the Philippines.

The slow adoption of Australian tree species raises questions as to what are the major impediments – e.g. whether there is simply a lack of planting stock and information about these species, whether they are unsuited on biological grounds, or whether there are economic, social, institutional or other constraints impeding adoption. Chapter 13 has pointed to some negative factors concerning use of Australian eucalypts in tropical developing countries, particularly India, which may have implications for the Philippines.

Identification of the major constraints is critical for policy purposes. For Australian research funding bodies, this will provide guidance on the social payoff to the Philippines of research by Australian scientists. It will assist decision-making on whether to continue supporting research into the growing of Australian species there – and, if so, which species to focus on – and on whether other measures are needed to maximise the social benefits from sunk research costs in the Philippines. For Philippines policy makers, an understanding of these impediments will be of value in planning forestry incentive programs and seeking overseas assistance.

This chapter reviews reasons why adoption rates of new forestry technology may be slow in a lesser developed country (LDC). This establishes a framework for discussion on the various categories of impediments as they apply to adoption of Australian timber species in the Philippines. Sections 3 to 7 consider various categories of constraints, and Section 8 summarises the discussion.

2. Reasons for slow adoption of new forestry technology

Many forestry stakeholders in the Philippines have been aware of the rapid growth rates achieved by Australian plantation species in the Philippines for the last two to three years. Nevertheless, little adoption of the Australian technologies has taken place during this time. A search of the forestry literature of LDCs was undertaken to gain an insight into the range of potential impediments to the adoption of Australian species in the Philippines. The results of this search are reported in Table 1, in which impediments are grouped as concerns over profitability, resource inputs, product markets and property rights, and attitudinal impediments. An 'X' indicates that the associated impediment was highlighted as an important constraint, or that the absence of this impediment has facilitated the adoption of plantation forestry. Although the literature focussed on impediments to small-scale forestry, most of the impediment categories highlighted in Table 1 are likely to be applicable to industrial growers. While it is difficult to draw general conclusions about the relative importance of different factors from Table 1, the classification provides a useful framework for examining the impediments retarding adoption of Australian forestry technologies in the Philippines.

3. Concerns about the level of profitability of Australian tree species

An expectation of profitability or efficient resource use on-farm is an important prerequisite to adoption of non-traditional tree species. The introduction of new species in the Philippines often also requires a concomitant distribution of adoption incentives – such as money, property rights and free seedlings – to the local people to increase the attractiveness of the new technology (Aguilar 1986).

Table 1: Frequently cited impediments to the adoption of new plantation technology

Impediment	Philippines[1]	Philippines[2]	Philippines[3]	Philippines[4]	Philippines[5]	Thailand[6]	Laos[7]	Bangladesh[8]	Nepal[9]	India[10]	India[11]	India[12]	India[13]	India[14]	India[15]	China[16]	Indonesia[17]	Kenya[18]
Profitability concerns																		
Lack of information about profitability		X		X														
Difficulty and cost of tree protection								X	X			X						
Expectation of low returns				X		X								X			X	
Long payback period and high private discount rate			X							X								
Resource inputs																		
Land and climate constraints	X							X	X			X						
Lack of labour								X	X			X						
Unavailability of seedlings					X		X	X	X								X	
Lack of knowledge and extension information					X		X	X	X			X						
Lack of access to finance	X							X		X		X					X	
Market constraints																		
Lack of timber markets	X				X	X					X	X		X				
Lack of market recognition of Australian species																		
Timber properties of Australian species		X																
Market distortions of crop subsidies																		
Property rights constraints																		
Landlord-tenant relationships, uncertain timber rights										X								
Insecure property rights to land and trees	X								X									
Impediments to log transport		X																
Other government regulations and disincentives						X									X		X	
Attitudinal impediments																		
Preference for multi-purpose trees	X				X	X		X	X									
Accessibility of nearby natural forest	X					X												
Negative attitudes to Australian species					X						X		X			X		X
Negative extension information			X				X				X							

[1] Pasicolan and Tracey (1998)
[2] Harrison and Herbohn (1999)
[3] Margraf and Milan (1996)
[4] Aguilar (1986)
[5] Nixon (2000)
[6] Amyot (1988)
[7] Wittrock (1996)
[8] Khaleque (1988)
[9] Dixit (1988)
[10] Shah (1988)
[11] Saxena (1992)
[12] Dhage et al. (1998)
[13] Chaturvedi (1988)
[14] Negi et al. (1996)
[15] Lal et al. (1997)
[16] Haishui (1988)
[17] Gunawan et al. (1998)
[18] Gustavsson and Kimeu (1992)

Lack of information about profitability

In general, lack of information on the profitability of tree growing is a common impediment to plantation forestry, even in developed countries. In the Philippines, the dearth of information is particularly severe for small-scale plantations and estimates of profitability have provided mixed signals. Some budgets have been prepared by ERDS (1998) for a range of traditional tree species in the Philippines; however, the estimates appear to be applicable to industrial forestry estates only and some are rather optimistic. For example, a 13-year rotation of bagras has an estimated NPV of P61,965 per ha, compared with P277,274 for a 15-year rotation of gmelina. Notably, the ERDS data do not include financial performance estimates for Australian tree species being trialled in ACIAR research. This study has highlighted the need for more information about plantation species performance in relation to site quality.

Problems with protecting trees

Wildfire, wandering livestock, timber theft and neighbours unhappy with borderline trees shading their land impede both small-scale and industrial forestry. Costs associated with protection reduce expected profitability. A farmer is unlikely to undertake major tree planting activities if neighbours light fires in the surrounding grasslands each year to encourage 'green pick' for livestock (Byron in press). Similarly, if livestock are left to roam free, farmers are likely to give up planting trees (Dixit 1988; Khaleque 1988). Tree theft is a potential problem in some parts of the Philippines (Heath 1999) and elsewhere (Gunawan et al. 1998). However, it was reported during a visit to Mindanao that Australian acacias and eucalypts have an advantage over some popular traditionally grown plantation species; their high timber density means they do not float well and are therefore less prone to pilfering near rivers.

Expectation of low returns

To date, there appears to have been insufficient evidence to convince landholders that high returns are possible from small-scale forestry. With regard to agricultural crops, Arnon (1989) asserted that in the early stages of technology transfer it is almost essential that increases of at least two or three times the normal yield be attained to ensure farmers attribute gains to the new technology; otherwise, it is doubtful that farmers will recognise the improved yield net of typical year-to-year productivity fluctuations, or accept that the additional management costs will pay for themselves. Such large improvements in timber yield with Australian species in the Philippines are unlikely, given the fast growth rates of some traditional species. Yield modelling reported in Chapter 7 adds further support to the assertion that yield premiums of this magnitude are unlikely to be achieved with the Australian species.

Baretto (1999), a farmer and furniture manufacturer in Bukidnon province, Mindanao, argued that the main reason farmers grow trees is to meet their own timber needs. He further noted that, if he were an average farmer with three hectares of land and no other source of income, he would devote all his land to cash crops and none to trees, because crops would generate greater income. In a study of eight upland social forestry projects in the Philippines, only 15–16% of participants surveyed stated that their expectations of benefits were fully or mostly met (Aguilar 1986).

Long payback period and high private discount rate

For the average Filipino farmer with one to three hectares and no additional sources of income, growing timber trees is usually not an option without considerable outside assistance. The attitude of upland farmers is a preference for present consumption (Segura-de los Angeles 1986; Sarre 1994). The typical 8- to 10-year rotations in farm forestry in the Philippines, while short by international standards, may be too long for many farmers to consider, since devoting land and valuable time to timber production reduces current levels of earnings from cash crops or from paid employment. Real interest rates are very high in the Philippines (of the order of 15–20%), and farmers are likely to adopt a high discount rate on forestry investments to account for the potential of a natural disaster, e.g. typhoon, wildfire.

4. Constraints imposed by limited access to resource inputs

The introduction of new technologies, such as those arising from ACIAR forestry trials in the Philippines, that potentially lead to a large increase in yields and incomes is only part of the process of technology transfer. Technological improvements will only be adopted if the appropriate inputs are available to the potential adopters. A number of resource input constraints to small-scale forestry have been reported in the literature, and appear to be highly relevant to small-scale forestry in the Philippines. These resource constraints are likely to impede adoption of Australian species by both farm and industrial tree growers, although the former are likely to have poorer access to resources than the financially and politically more powerful industrial companies.

Constraints due to land and climate

The availability of land for farmers to grow trees on is generally not considered an important impediment to the adoption of the Australian technology in the Philippines. Many farmers have areas on their property that are unsuitable for cash crops, and cleared spaces around their homesteads that could be planted with trees. Even if such areas are unavailable, borderline tree plantings can be (and often are) undertaken. Nevertheless, Pasicolan and Tracey (1998) found that the need to intercrop trees with agricultural crops is an important consideration of land-poor Filipino farmers when choosing species. Chapter 11 discusses the potential for Australian species to be incorporated into this management system. Large areas of upland country are under the control of DENR and potentially available for forestry, although this is subject to illegal squatting and Ancestral Domain land claims.

In the typhoon belt, Australian acacias are gaining a reputation for being brittle in strong winds and more prone to damage than the traditionally grown *P. falcataria* and *G. arborea*. However, this may simply shift the demand of farm and industrial tree growers to Australian eucalypts, which are recognised as being more flexible and resistant to typhoon damage than the traditionally grown species, including the native eucalypt (Heath 1999).

Lack of labour and critical time demands of other farm activities

Tree planting and rice planting coincide with the onset of the monsoon in about June in some Northern Hemisphere developing countries – e.g. Nepal (Dixit 1988), India (Dhage et al. 1998) and the Philippines (Heath 1999). There are often labour shortages at this time of the year. Under these circumstances, rice is given top priority and forestry is often neglected (Dixit 1988).

Unavailability of seedlings of Australian species

For farming communities without the assistance of NGOs, the poor accessibility and expense of planting stock are perhaps the greatest impediments to the growing of eucalypts and acacias. At the Bukidnon Forests Incorporated nursery, one of the few places where they are available, eucalypt and acacia seedlings range in price from P4.5 to P10 each, compared to P3 for *G. arborea* and *S. macrophylla*. Compounding the problem of price differential is the need for training of nursery staff in raising eucalypt seedlings, because they are more difficult to propagate than traditional species. Even the Philippines Department of Environment and Natural Resources (DENR) staff appear to have difficulty in raising eucalypt seedlings – which, it has been said, contributes to their continuing recommendation of

G. arborea for plantation forestry in preference to Australian species (Brown 1999). However, with training from ACIAR and NGOs, farmers in some community forestry programs are now producing eucalypt seedlings in their own nurseries.

Lack of knowledge about growing timber trees

Most of the farmers with whom the authors spoke in the Philippines had little knowledge about growing trees, and had been influenced to grow trees by significant financial and technical support from NGOs. To obtain land rights through a Certificate of Stewardship, settlers are required to plant 20% of their land to trees. However, when farmers lack forestry knowledge and are unwilling to manage a plantation, tree growth and yield are likely to be poor. In particular, farmers may stick to well-known species despite the existence of species more appropriate for their particular location. Poor site–species matching will also contribute to low yields and further reinforce negative impressions of forestry as an alternative, or complementary, land use to existing ones.

Lack of extension advice

While some extension information about tree farming was found – e.g. the PCARRD 'The Philippines Recommends' series and the ERDS tree growing budgets (ERDS 1998) – in general, the large territory and limited budget of the DENR limit provision of extension services to landholders. This responsibility appears to have been unofficially handed over to the multitude of NGOs operating in rural parts of the Philippines.

Lack of access to finance

The establishment of a forestry enterprise can require large initial cash outlays from Filipino farmers, while returns may not be received for 8 to 10 years. In the Philippines, farm credit is difficult to obtain and available for only short periods (typically up to 2 years). Credit for longer periods can be obtained only at very high rates of interest (Harrison and Herbohn 1999; Harrison et al. 2000). Limited knowledge about accounting, and financial analysis and banking procedures, also inhibits the access of smallholders to credit. Often finance is more readily available to industrial forest growers, with their greater access to capital markets and government loans at concessional interest rates, and access to international aid funding.

5. Market constraints

A variety of market factors are likely to impede the adoption of Australian tree species in the Philippines.

Lack of timber markets

Heath (1999) commented that Australian species have been planted in the Philippines without enough effort being devoted to ensuring marketable end products will be grown. According to Byron (in press), wherever farm forestry is flourishing there are strong, credible signals (sometimes reinforced by advance-sale contracts) that buyers will purchase the tree products. Farmers generally will not establish trees in the 'hope' that a market will arise. Doubts are now being raised in Punjab, India, regarding the economic compatibility of eucalypts on farms because of undeveloped and under-developed markets for eucalypt timber (Negi et al. 1996). Nevertheless, anecdotal evidence for the Philippines suggests that plantation owners are unlikely to experience difficulties selling their timber.

Lack of market recognition of Australian timber species

A lack of product recognition by consumers is a well-recognised impediment to the launch of any new product in a market place. Potential consumers will be uncertain about the quality and uses of the new product. The risk-adverse behaviour of Filipinos will tend to favour the traditional timber species. Overcoming this impediment is a matter of product promotion and time for acceptance. Given the current and expected future shortage of timber in the Philippines, it is likely that consumers will be open to any form of timber, providing it is readily available and of acceptable quality.

Concern about timber quality of Australian species

Eucalypts have an unfavourable reputation as a plantation (sawlog) timber species, primarily because they are difficult to season (i.e. dry) and can easily crack if not handled properly (Chaturvedi 1983; Gustavsson and Kimeu 1992). Young eucalypt logs tend to have a high level of growth stresses, which results in end cracks and splits, sometimes of considerable size, as soon as the tree is felled and cut into planks (Tewari 1992). Among the main problems encountered in the sawing of young, rapidly grown eucalypt trees is that they exhibit excessive shrinkage resulting in bowing of the timber (Hillis 1978). In contrast, the commonly grown traditional species, *G. arborea*, seasons readily and its board shape tends to be stable due to low shrinkage (FPRDI undated, a). However, appropriate milling techniques, such as quarter sawing, can be used to reduce the effects of shrinkage and twisting in eucalypt timber (Bhat 1992; Waugh 1996). Furthermore, sawing difficulties appear to be highly species-specific, with some species – such as *E. grandis*, *E. saligna* and *E. maculata* – presenting few problems (Waugh 1996). Similarly, sawlogs from a 13-year-old *E. globulus* trial have been found suitable for production of appearance-grade timber (Moore et al. 1996).

The disadvantages of eucalypt timbers are somewhat offset by their strength, durability and, in the case of *E. camaldulensis* and *E. tereticornis*, their termite resistance (Boland et al. 1992). The nail and screw holding capacity of *E. tereticornis* in India was found to be better than that of mango timber (commonly used in India for crates), and comparable with that of teak. Wood density provides a reliable, although not always direct, indication of the strength of a timber (Hillis 1978). Mature *E. camaldulensis*, *E. tereticornis* and *E. pellita* in Australia have wood densities of about 1000 kg/m^3 (Boland et al. 1992). According to studies in Israel by Tischler (1976, cited in Hillis 1978), densities of younger trees are likely to be between 500 kg/m^3 and 600 kg/m^3. This compares favourably with the density of the Philippines native *E. deglupta,* which has been estimated at between 420 kg/m^3 and 510 kg/m^3 for plantation-grown timber in Papua New Guinea with a small end diameter of 34 cm (FPRDI undated, b).

The density of *A. mangium* in the Philippines is reportedly 570 kg/m^3 (FPRDI undated, c). However, *A. mangium* does not have the desirable durability and pest and disease resistance properties of the eucalypts, with its sapwood and heartwood being susceptible to fungal and termite attack. Nevertheless, the timber of this species saws easily and has attractive shaping and turning qualities (FPRDI undated, c).

The densities of the Australian species make them a more attractive timber for many purposes than *G. arborea* (density 400–540 kg/m^3) and *P. falcataria* (234–430 kg/m^3), which are comparatively lower-strength timbers (ERDS 1998; FPRDI undated, a) with low natural durability (Williamson 1993). While the Australian species provide sound general constructional timbers, *G. arborea* is only suitable for light structural timber use and *P. falcataria* is restricted to uses where strength, hardness and durability are not critical requirements (ERDS 1998; FPRDI undated, a). Eucalypts are commonly grown for house poles and fuelwood in Kenya, where local carpenters even make furniture from the timber (Gustavsson and Kimeu 1992).

Market distortions due to crop subsidies

Heath (1999) argued that removing or reducing subsidies provided by the government for the production of particular cash crops could substantially increase the attractiveness of adopting tree-growing technologies. The argument for crop subsidies is presumably the high priority placed on food security. However, food crises are not common in the Philippines and timber self-sufficiency has become a higher priority.

6. Property rights constraints

The prevailing property rights regime is critical to land management and technology adoption. The absence of well-defined, exclusive, secure, enforceable and transferable property rights favours short-term production maximisation in the Philippines. Timber plantations may require DENR permission to harvest and be subject to costly delays at plantation timber certification road stops. These impediments are likely to greatly inhibit industrial and small-scale forestry.

Landlord–tenant relationships and insecurity of timber rights

Where estates are owned by absentee landlords and rented to farmers, the farmers are reluctant to establish plantations because they do not know with certainty whether the trees will be theirs to harvest in the future (Dixit 1988). In addition, the landlord has little incentive to invest money in planting trees on the farm, since the majority of the benefits are likely to accrue to the tenants.

Insecure property rights to land and trees

Pasicolan and Tracey (1998) identified property rights to the land, the trees or both as being the most important factor in a farmer's decision about whether to plant trees on Luzon island. Property rights over trees were an evident concern of farmers contemplating forestry at meetings addressed by government officials during a visit to the Philippines by one of the authors. Property rights are also of concern to industrial plantation companies in the Philippines. There are currently great numbers of Community and Ancestral Domain claims being made over industrial forestry land, which may make industrial forestry unsuitable in large areas of the country (Pollisco 1999). Even relatively small land holdings are subject to subdivision under the agrarian reform program, increasing risks associated with large-scale plantation forestry investments.

Impediments to log transport

At the time of harvest, permission must be obtained from the local authorities and, if the harvest is large, also from DENR. A certification fee of P65 per truckload of timber must be paid to DENR. Numerous DENR roadside checkpoints, charged with the responsibility of ensuring the timber has not been harvested illegally from natural forests, often cause expensive delays. The certification paper issued by DENR should provide access through these checkpoints; however, in practice, thousands of pesos may be required to bribe staff. Anecdotal evidence during visits to the Philippines suggests the concept of these roadside checkpoints has also become popular among various elements of rural society, including local church groups, NGOs and militia, each requiring payment to allow the timber trucks to pass. Two of the authors (Harrison and Herbohn) received a report from a local mill owner that a recently received truck load of timber from the highlands had had to pass through some 40 checkpoints, with payments by way of bribes of approximately P5000 required. Such checkpoints are also referred to as 'cash points' because of the need to pay bribes in order to pass.

Other government regulations and disincentives

The general attitude that government places obstacles in the way of tree farming was observed in field visits. As well as promoting forestry, DENR is responsible for implementation of environmental protection legislation and regulations. Sometimes landholders appeared uncertain about whether tree felling restrictions apply to farm forestry. Long delays in obtaining permission from DENR for harvesting of woodlots are a common complaint.

7. Attitudinal impediments to the adoption of new species

People are often cautious about new technology and resist change. Potential small-scale growers may resist adopting Australian timber species because land may be considered too valuable to grow timber, especially if there are natural forests nearby or multi-purpose trees could be grown instead. Some communities may have negative attitudes to Australian species because of perceived impacts on their farms from resource-demanding, fast-growing trees. Although the attitudes of small-scale growers may be negative, large-scale timber growers appeared to have an open minded acceptance of Australian species.

Preference for multi-purpose trees

The preference for multi-purpose trees is unlikely to be relevant to industrial forest growers, but as in many other parts of the world – e.g. Bangladesh (Khaleque 1988) and Nepal (Dixit et al. 1988) – farmers in the Philippines generally prefer to grow species that provide several products and services. For example, mango trees are popular among Filipino farmers because they produce valuable fruit, can be pruned for fuelwood, and can be harvested as a valuable lumber. Venn (1999) noted that all the squatters and farmers with land rights for forestry to whom he spoke on a visit to the Philippines said that, if given a choice of planting either a fruit tree or a eucalypt, they would choose the former. Uses of eucalypts, however, are not entirely confined to their timber. Around Tacloban City on Leyte island a market has been developed for *Eucalyptus* oil, which is highly regarded as a mosquito repellent (Germano 1999).

Accessibility of nearby native forests

Access to natural forests is an impediment to small-scale plantations, because farmers will be reluctant to grow timber in place of cash crops when a plentiful, 'free' resource is nearby. However, access is decreasing rapidly as the remaining natural forests are cleared.

Negative attitudes towards Australian species

There is a great deal of literature discussing negative attitudes of farmers towards eucalypts (e.g. Shiva and Bandyopadhyay 1983; Florence 1986, Shah 1988, Gustavsson and Kimeu 1992). In contrast, there does not appear to be any negative literature of this kind aimed at Australian acacias, grevilleas, casuarinas and other species being trialled in the Philippines. The following discussion is focussed on Australian eucalypts, although some of the arguments may also apply to fast-growing acacia species. Chapter 13 has reviewed these issues with respect to eucalypts in east India. In general, the literature suggests farmers tend to follow traditional practices, and are cautious about the adoption of new technology (e.g. Dixit 1988). This seems to apply in the Philippines as much as elsewhere, as explained by the Filipino characteristics of 'segurista' and 'pilospo'. The former is a reluctance to try anything new before success is guaranteed, while the latter is a sceptical attitude to collectively established change (Ypma and Telan 1992).

Allelopathy of Australian eucalypts

There is a belief in some countries that the eucalypt is strongly allelopathic; that is, it produces foliar and root exudates which are directly toxic to other plants (Florence 1996). It is also said that, where a eucalypt stand is harvested and replaced by an agricultural crop, that crop will not thrive – at least for several years. Ninety percent of farmers interviewed by Gustavsson and Kimeu (1992) in Kenya complained that eucalypt trees had a negative effect on agricultural crops up to 5 metres from the bole of the trees. Ahmed (1989, cited in Tewari 1992) reported that eucalypt trees planted on all sides of field bunds in India had a negligible effect on agricultural production for the first 2 years, gradually increasing to a 13.6% reduction of yields relative to a site with no border trees by age five to six. Beyond 6 years of age the trees had more substantial impacts on agricultural yields, reducing production by 26.4% at age 8 years and by 48.8% at 10 years. Saxena (1992) attested that agricultural losses are visible up to 10 m from the eucalypt tree line.

There is no strong evidence for allelopathy (Shah 1988; Florence 1996). While it may be true that eucalypts affect the soil chemistry and microbiology, this may have more to do with the long-term effects of incorporation of eucalypt leaf litter into the soil. Florence (1996) asserted that it may be more appropriate to interpret any effects of the eucalypt on other vegetation in terms of the genus's great capacity to compete for soil resources (water and nutrients).

Water use of Australian eucalypts

Another complaint often levelled against eucalypts is that they consume too much water. For example, farmers in Kenya complained that, after the introduction of eucalypt trees, waterways became dry (Gustavsson and Kimeu 1992). Eucalypts consume a lot of water when it is available, because they have high biomass production. However, eucalypts also appear to be highly water-efficient relative to other timber species, as revealed in field observations comparing biomass production per litre of water used (Chapter 13). For example, a *Eucalyptus* hybrid was found to produce 2.54 times as much biomass per litre of water as *P. falcataria*, one of the traditionally grown species in the Philippines. In more arid regions, eucalypts may not be the best choice for plantations because, while being water-efficient, they do consume greater total volumes of water than many other species to maintain their rapid biomass accumulation rate.

Depletion of soil nutrients by Australian eucalypts

Eucalypts are highly efficient in their consumption of nutrients per unit of biomass, ranking above *Tectona grandis*, *Shorea robusta* and *Pinus roxburghii* in India (Shah 1988). However, the argument against the eucalypts is that the total quantity of nutrients accumulated by a tree over time is high relative to other species, not that nutrient efficiency is low. There may be some justification under particular conditions for this criticism. For example, successive short rotations of fast-growing species where the whole of the biomass, including the forest floor litter, is removed from the site would almost certainly lead to soil nutrient status decline (Florence 1996). This appears to be a relatively common practice in the Philippines. Nevertheless, Florence (1996) asserted that the drain on the nutrient pool is unlikely to be greater than that for other fast-growing tree species. Gustavsson and Kimeu (1992) found that, even after several short rotations of eucalypts in Kenya, the growth rates of the trees had not declined.

Negative extension information about exotics, including Australian species

Extension literature in the Philippines promotes growing traditional species and provides negative comment about exotic species, including (by implication) Australian eucalypts. For example, Margraf and Milan (1996) have produced a forest rehabilitation guide for farmers which argues that there are greater risks with non-traditional species:

> 'All in all there are about 3000 different tree species known from the Philippines. So there is really no need to plant exotic fast growing trees which are even more prone to typhoons and pest attacks' (Margraf and Milan 1996, p. S-3).

They take the view that local species (which include some popular traditional species) are better adapted to local conditions:

> 'This [reforestation] scheme is based on the premise that a farming system in the humid tropics is increasingly more sustainable the closer it is in its species composition to the original local rainforest' (p. 6)...'There are enough Philippine tree species of high quality, fast growing, and perfectly adapted to the local climate and soil conditions' (p. S-3).

Margraf and Milan (1996) also argue that although introduced species (presumably including Australian eucalypts, but possibly not traditionally grown introduced species) have rapid early growth, this does not continue to harvest age:

'... most introduced species perform well at the start and show their weaknesses later. For example, most introduced species are usually badly damaged by typhoons. It is therefore strongly recommended to plant many different Philippine tree species which even benefit each other mutually' (p. S-22).

8. Discussion

Modest returns and a long payback period will, in general, mean that tree farming is not particularly profitable relative to cash crops. Hence, small-scale plantings are likely to continue to be mainly on roadsides, field boundaries and under-utilised farmland. Expectations of low returns and a lack of knowledge both reflect the dearth of information on Australian species in the Philippines. The financial performance estimates for Australian species reported in Chapter 8 suggest that relatively low returns to farmers are likely to be an important continuing impediment in the Philippines. However, further trial observations could lead to major revisions in the profitability rankings of traditional and Australian species, especially on low-fertility and degraded sites.

The superior resistance of Australian eucalypts to typhoons could encourage the adoption of these species by tree growers in typhoon zones of the country (in Leyte and further north). If farmers perceive financial benefits from growing trees, then encouraging the community to work together could reduce the risk of hazards – such as fire and livestock grazing – and raise the welfare of all farmers. This has been achieved in villages of Sanggau District in West Kalimantan, Indonesia, where fire regulations formulated and implemented by villagers have reduced the frequency of fires in the area from several every year to only one in the last 5 years (Byron in press).

While the Philippines has a large rural population, overlap in the peak work periods for cropping and forestry is a real impediment to tree planting. Overlap in the planting times for rice and trees is not a problem in the uplands where little rice is grown, although there could be a clash with planting other crops such as maize. This clash could probably be avoided in many parts of the Philippines by planting trees, or at least preparing land for tree planting, in the weeks immediately prior to the onset of the monsoon.

To minimise cracks and splits in eucalypt timbers, Tewari (1992) recommended storage of logs under shade and, if possible, under water sprays for some months after cutting. Under shade alone, *E. tereticornis* stored without objectionable cracking for 6 months in India. Pre-seasoning chemical treatment with urea and kiln drying have also been found to reduce cracking and warping. While industrial companies are likely to have the resources to undertake special drying procedures, wood quality concerns could still be a serious impediment to the adoption of Australian species on-farm. Therefore, farmers may be better advised to plant *A. mangium* in preference to Australian eucalypt species where high density and durability are not essential timber requirements. However, the benefits of more stable timber from the former species may be offset by requirements for more intensive silvicultural management, e.g. pruning, while many of the eucalypts are self-pruning. In addition, where markets for roundwood products such as electrical poles exist, eucalypts could be managed to meet these specifications, avoiding the need for sawing.

It is likely that uncertain property rights will continue to discourage landholders from planting trees, including Australian species. Squatters in the Philippines probably consider the lack of property rights the most important impediment to them adopting the Australian tree technologies (Pasicolan and Tracey 1998). Ancestral Domain claims could become a major impediment to industrial forestry.

The negative attitudes expressed by researchers and farmers in other countries regarding Australian eucalypts are unlikely to affect the adoption of Australian species in the Philippines, despite the existence of research groups championing their own cause by denigrating the potential of introduced species. These concerns were found to be of no importance to industrial growers in the Philippines, and Filipino farmers were, generally, found to be unaware of them. However, it would appear that Filipino farmers have a preference for multipurpose trees, particularly fruit trees, over timber trees. Farmers indicated that they are unlikely to purchase seedlings of Australian tree species, but will plant them if seedlings are distributed free of cost.

Farmers who are not being assisted by NGOs (the majority of farmers) are unlikely to adopt the Australian technology at present if they face resource input impediments. This is due to their powerlessness with regard to the accessibility of seedlings and credit, and the recommendation of traditional species by DENR. In contrast, industrial companies generally have the resources to circumvent these impediments.

In summary, it was found that encouraging farmers and industrial companies to grow Australian trees is not a simple matter of demonstrating the remarkable growth rates and financial profitability of the Australian species. The Philippines is a low-income country, which does not favour adoption of enterprises with a long payback period. In the short to medium term, prospects for the adoption of Australian species by small-scale, financially challenged tree growers are poor in the absence of substantial NGO support. Chapter 7 indicated that the Australian species are likely to be better adapted to degraded sites than traditional species, although there is no conclusive evidence for the Philippines and the risk-averse rural poor generally have little access to resources that would overcome the impediments discussed in this chapter to facilitate adoption of the Australian species. Industrial forest growers are better able to take advantage of opportunities arising from research into the performance of Australian species in the Philippines. Access to necessary resources is unlikely to be a constraint and concerns about wood quality can be reduced or eliminated with appropriate storing and sawing techniques. Prospects for adoption by industrial growers in the medium term appear high if yield and wood quality results from plantings continue to be favourable.

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Chapter 15

Future Prospects for Australian Tree Species in the Philippines

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This chapter reviews findings of the socio-economic evaluation of prospects for Australian tree species in the Philippines. The adoption of Australian tree species to date, estimates of their economic performance, major impediments and prospects for greater uptake in Philippines forestry are reviewed. It is concluded that Australian eucalypts, acacias and other species do have an important potential role, particularly for industrial forestry, and that uptake is likely to increase steadily.

1. Introduction

Chapter 1 noted the relatively slow uptake of Australian tree species in the Philippines, particularly in farm forestry, and raised the question of whether these species are unsuitable for the Philippines on economic, social or biological grounds or whether further actions are required beyond the experimental work if the potential socio-economic payoff from the ACIAR research is to be realised. This chapter presents a summary of the findings from the socio-economic study.

The next section reviews the research methodology employed in this study, and the strengths and limitations of this methodology. Issues which have led to recognition of the need to expand tree planting in the Philippines are then reviewed. Comments are made about the performance of Australian tree species. Adoption progress is then reviewed. Factors most likely to impede adoption of Australian species are discussed with particular reference to eucalypts, and some measures to overcome these are suggested. Some judgments about future prospects are then presented, and implications are drawn for further research.

2. Research methodology and limitations

The approach adopted in this study has been to develop stand yield and financial models for traditional tree species and for Australian eucalypts and acacias in the Philippines, and to carry out a largely qualitative study of the potential role of Australian species in the various forestry systems – grouped as industrial forestry, farm and community forestry and agroforestry – and the factors which may impede adoption. Four members of the socio-economic research group made visits to the Philippines, where they inspected plantations and farm forestry and trial sites and held discussions with forestry administrators and researchers. Semi-formal surveys of landholders and forestry experts were conducted. The work in the Philippines was supplemented by projects of the researchers in other countries and literature review. The study benefited greatly from the support provided to the two principal researchers by two highly capable honours students – Tyron Venn (The University of Queensland) and Brendan Nixon (James Cook University) – who have contributed to this report. Guidance and assistance in travels by Dr Dart and Dr Brown, carrying out ACIAR Project FST 96/110, was also invaluable.

It was soon realised that stand growth observations for Australian eucalypts and acacias in the Philippines are of too short a duration to provide a basis on their own for yield predictions. An innovative approach to stand yield modelling under sparse data, in which the limited trial data from the Philippines are combined with trial data from other countries, was devised. Also, yields of industrial and farm forestry are predicted within the same models, which incorporate a yield leakage factor for less intensive silviculture on-farm.

The stand yield modelling in this study faced a number of limitations. Yield data for Australian tree species in the Philippines cover only 3 to 4 years of plantation growth. Data from other countries had to be used to draw inferences about growth curves for older plantations. A thorough search was conducted, which yielded a reasonable amount of information about the growth of Australian eucalypts and acacias in various countries. Yield predictions indicate that the Australian species, other than *Acacia mangium*, are relatively uncompetitive with traditional (including some exotic) species in the Philippines, particularly for farm forestry. However, this conclusion is complicated by a number of factors, including:

- the need to rely on 'international data', some of which came from a number of degraded sites and hence may have led to downwardly biased estimates of growth for older trees.
- a shortage of trials in which both traditional and Australian species have been grown, and hence an inability to compare performances on the same site.
- lack of information about the relative site characteristics upon which yields for Australian and traditional species are based. It could be that the comparison being made is of traditional species on superior sites versus Australian species on average sites.
- lack of information about the performance of Australian tree species on problem sites. It is generally considered that there are a range of site types where particular eucalypt species would perform adequately while traditional species would fail, but no information has been obtained to support this view for the Philippines.

Measurement of trees in the ACIAR trials had been discontinued at the time of the visits, due to budgetary constraints. With further trial data, it could be that the yield estimates of the Australian species will be upgraded.

Timber prices adopted in the financial analysis are those observed in lumber markets or recommended by Bukidnon Forests Incorporated. It is unlikely that there will be any large increase in timber production in the Philippines in the near future, and the growing shortage of timber could lead to increases in its real price (net of the inflation rate), and hence greater profitability for small-scale forestry. On the other hand, the struggling national economy and the limited ability of timber purchasers to pay higher prices will constrain real price increases.

Had resources permitted, it would have been desirable to carry out systematic surveys of the forestry practices and attitudes of the major forestry stakeholders – industrial foresters, farmers, community forestry participants, DENR officers, university researchers, timber companies and merchants. Such surveys would have provided greater confidence in some of the implications from the study regarding the potential for and impediments to forestry with Australian species.

3. The imperative to expand tree planting programs in the Philippines

Chapter 3 showed that there are compelling reasons to expand afforestation efforts in the Philippines. Timber shortage and the consequent high expenditure on imports are a drain on the balance of payments. The need to make affordable timber available to families for housing, and to protect the copra industry, act to increase the government priority on expanding forestry. In addition, afforestation is needed to redress the environmental problems associated with excessive forest clearing – e.g. to reduce soil erosion, lowland flooding and sedimentation of watercourses. In recent times there has been a particular focus on farm and community forestry; this has the potential to assist the livelihood of a low-income section of the community, reducing the costs of other welfare programs. It also has implications for the future role of Australian tree species in the Philippines.

4. Performance of Australian tree species

The field trials under ACIAR Project FST 96/110 have involved eucalypts, acacias, grevilleas and casuarinas. ACIAR site–species matching and nutrient trials have revealed that eucalypts and acacias, with appropriate silvicultural technology, can make spectacular early growth in the Philippines. Some of the high-performing species have included *Eucalyptus pellita*, *E. urophylla* - *E.grandis* hybrid, *E. camaldulensis* and *Acacia mangium*.

Results of stand growth and financial modelling have suggested a somewhat disappointing performance by Australian species relative to traditional species. Only *A. mangium* appears to compete well on financial terms with traditional species. As mentioned in Section 3, the yield, and hence financial, predictions have a high degree of uncertainty due to limitations of the data upon which they are based. Predictions from the yield models could well underestimate the growth performance of Australian tree species relative to traditional species, and the performance of eucalypts relative to acacias, in the Philippines. Some of the Australian species also have desirable properties with regard to fire resistance and regeneration capacity, tolerance of poor sites, and ability to withstand high wind velocity. Also, some of the eucalypts provide better-quality poles and pulpwood than traditional species. These specific characteristics and uses have largely been excluded from the financial analysis.

5. Progress in adoption and potential uses of Australian tree species in the Philippines

In general, the rate of adoption of Australian species in farm forestry appears slow. Some plantings of *A. mangium* were noted. Surprisingly widespread growing of gmelina – often in very small stands such as fence-line plantings – are apparent to the visitor, particularly in Mindanao. There is evidence that Australian eucalypts and acacias attract lower timber prices than traditional species. In industrial forestry, considerable use is being made of eucalypts (especially *E. camaldulensis*). Some eucalypt species are well suited to pole production. Considerable market potential would appear to exist for timber poles in the Philippines – for housing, phone lines and electricity transmission. Widespread use is being made of concrete poles, although their high weight and the fact that they use non-renewable resources suggest that future prospects for eucalypt poles are sound. As noted in Chapter 5, eucalypts and acacias have been adopted to some extent in community forestry.

It would appear that some of the Australian species offer promise in agroforestry systems, such as alley cropping. *E. camaldulensis* appears promising in this regard and, incidentally, is a useful species where wet soils must be tolerated. Casuarinas appear well suited to problem areas such as sandy and saline soils and windy areas, and hence have high potential for environmental plantings.

6. Impediments to tree growing and possible measures to overcome them

While large areas of government-controlled upland country are available for expansion of forestry, a surprisingly large number of potential impediments, in relation to industrial and small-scale forestry, have been noted. Important among these for farm forestry are property rights issues, especially concerning land tenure and uncertainty about returns, the long payback period and shortage of finance, and of labour at some critical periods of the year. For industrial forestry, uncertain land tenure (in relation to ancestral domain claims and illegal settlers), and risk of wildfire and windstorm are important impediments. Insurgency and labour disputes can also arise in some areas. Considerable organisation and finance are required to establish new community forestry projects.

Some particular impediments were observed in relation to Australian tree species. Negative attitudes to Australian eucalypts are apparent in other tropical countries, though the extent to which they influence the thinking of Philippines tree growers is difficult to determine. There appear to be negative comments about exotics in extension material, and possibly negative attitudes among forestry officials to eucalypt species. The unavailability, or higher price, of seedlings of Australian species was frequently encountered as a reason for not adopting these species in small-scale forestry.

Probably little can be done quickly to overcome land tenure uncertainty. Agrarian reform and indigenous land rights are issues which have arisen in the Philippines, as in many other countries, and require negotiation between the various stakeholder groups. There are probably few shortcuts to the resolution of these issues.

Recommendations for overcoming impediments to adoption

Some of the possible measures to promote adoption are discussed below:

Demonstrating the growth performance of Australian species

Again, research such as in the current ACIAR forest technology project appears the best way to achieve this aim. However, the short term of existing stand growth observations and the need for further monitoring of tree performance as these plantings progress towards harvest age should be noted.

Demonstrating the adaptability of Australian species

Australian tree species have been found suitable for a variety of sites, and useful in environmental as well as production plantings. The adaptability of the Australian species and their usefulness on problem sites – including *E. camaldulensis* on wet sites and *Casuarina* spp. on wet and saline sites – are probably not widely recognised in the Philippines. More demonstrations of the versatility of Australian species could lead to their wider adoption in situations where they have clear advantages over traditional species.

Assistance in seed germination and seedling production

An apparent impediment to adoption of Australian tree species in community and farm forestry is difficulty in producing seedlings, particularly of eucalypts. The unavailability or higher price of seedlings of Australian species was frequently encountered as a reason for not adopting these species in small-scale forestry. ACIAR

Project 96/110 has been active in the transfer of seedling production technology and establishment of small nurseries. There is scope for expansion of this activity, though the potential for competition with nurseries of industrial forestry companies needs to be kept in mind.

Creating awareness within the DENR concerning the need for strengthening of property rights for plantation forestry

One objective of this report has been to identify the constraints on further industrial and small-scale forestry. It is apparent that weak property rights of tree growers are an important impediment to planting. Suggesting that a government change its property rights regime is obviously a sensitive issue. However, a demonstration of the adverse impacts of uncertain property rights can lead to increased understanding by the domestic government. Probably little can be done quickly to overcome land tenure uncertainty. Agrarian reform and indigenous land rights are difficult issues in the Philippines, as in many other countries, and require negotiation between the various stakeholder groups and community consensus. There are probably few shortcuts to the resolution of these issues.

Recognition of the actual and potential contribution of international NGOs

A very large number of domestic and international NGOs operate in the Philippines, and some of these play an important role in community forestry projects. At the same time, concern was noted about the self-serving nature of some NGOs. A more formal role for NGOs as subcontractors to the DENR could greatly facilitate some community forestry projects. This could be an effective means of more rapid formation of new community forestry groups, although there is a risk of adding a further administrative layer to an already highly bureaucratic system.

Overcoming negative attitudes to Australian species

Experimental plots and discussions between a network of research collaborators, as implemented under Project 96/110, appear effective means of overcoming misunderstandings and misinformation about Australian species.

7. Future prospects for Australian tree species

The strong imperatives for reforestation, government support for tree planting, and the recognised values of Australian eucalypts, acacias and casuarinas would suggest that the area planted to these species will increase over time. It is probable that they will come to be accepted among the suite of favoured species for industrial and small-scale forestry. As noted in Chapter 10, there is considerable use of Australian tree species in community forestry.

While the rate of adoption of Australian forestry technology in the Philippines appears relatively slow, it is probable that the use of Australian tree species will increase progressively over time. These species have some potential for lumber, but could introduce a need for additional timber curing facilities and skills. The plentiful supply of limestone and sand, and the shortage of timber, has led to use of concrete poles. However, the greater weight and transport cost of concrete poles, and the fact that they use non-renewable resources, can be expected to lead to a sound market for timber poles as telephone and electrification expand or infrastructure becomes due for replacement. The high suitability of eucalypts and acacias for hardwood pulp – for paper, rayon and other products – and the suitability of these species for fuelwood and house poles should also lead to assured markets. Eucalypts and acacias are finding use in industrial forestry in other tropical countries, including India, and use in industrial forestry for products such as pulpwood and poles may become their most important application in the Philippines. In summary, as the relative merits of these species become better known over time in the Philippines they will probably become among the favoured species for pulpwood, poles and fuelwood.

There is also potential for Australian tree species not yet trialled in the Philippines. For example, some of the fast-growing Australian tropical cabinet species could have a role as alternatives to traditional species in farm forestry – e.g. *Flindersia* and *Eleocarpus* spp.

8. Suggestions for further research

A number of potential areas for further socio-economic research into forestry – particularly non-industrial forestry – in the Philippines have been identified as a result of this study. These studies would involve, but go beyond, the introduction of Australian tree species.

Further growth measurements of ACIAR trials and other plantings of Australian species

Some of the questions raised concerning the yield and financial performance of Australian tree species would be clarified if further growth monitoring of plots established under ACIAR Project FST 96/110, or of these species in industrial plantings, were undertaken. The project work conducted to date has led to an effective communication network being established, and improved knowledge about site requirements, nutrient limitations and seedling production under local conditions. The research appears to be highly thought of in the Philippines. It may be that, with a little extra effort, there would be a considerable boost to uptake of Australian tree technology. An area of promise would appear to be further monitoring of the growth performance in trials with Australian species. This seems particularly important given the existence of extension literature in the Philippines which argues that growth rates of exotic species fall away after early impressive performance.

Trialling specific Australian species for specific purposes

A large number of eucalypt species have been grown in plantations, and species or varieties are suitable for a wide variety of sites. This creates the possibility of comparisons of species for fire resistance and regeneration capacities after fire, and of the abilities of plantations and of pole timber to cope with typhoons. As well, there appears to be considerable scope for trialling Australian tree species in agroforestry systems, which can be highly productive and relatively fire-proof systems that might fit well within community forestry programs. Given the capacity building which has taken place in ACIAR Project 96/110, a suitable research model may be to assist Filipino scientists to conduct their own silvicultural trials.

Trials with further Australian tree species

As noted above, it is possible that some of the Australian high-value tropical species such as *Flindersia* and *Eleocarpus* spp. could have a role in small-scale forestry, but this would need to be tested by field trials of these species. Within the CBFM program, it is possible that some of the fast-growing Australian tropical rainforest species could play an important role.

Overcoming impediments to tree growing

This study has identified a variety of socio-economic impediments to expansion of forestry in general, and use of Australian species in particular, in the Philippines. Studies into measures to overcome these impediments would be of value.

Identifying landholder attitudes and favoured assistance measures with respect to forestry

A more specific study in terms of impediments to tree planting would involve classifying landholders into groups in relation to attitudes to forestry, and identifying what types of incentive programs would be most effective in bringing about adoption of forestry. Data collection would probably involve a number of community meetings, with general discussion followed by interviews of individual landholders by Tagalog-speaking enumerators. It might be possible to include in these meetings some form of focus group approach to seeking consensus views. The data would be subject to cluster analysis to identify distinct landholder groups (as has been carried out for north Queensland landholders).

Land availability for forestry

While there is a general view that a large area of land is available for forestry in the Philippine uplands, this view does not appear to have been well tested. A land suitability study could be undertaken on a particular island – say Leyte – to determine what area is suitable for growing which species. This might involve a geographical information systems (GIS) approach, using layers for soil type, current vegetation and conservation value, areas under control of government and not subject to indigenous domain claims, accessibility of markets, and so on.

Community based forest management

The future importance of community forestry programs in the Philippines is uncertain. These offer considerable promise for sustainable land use, empowerment of villagers, training in silvicultural and furniture production skills, and production of timber and value-added products. However, the circumstances under which new community forestry programs become established and succeed are not entirely clear, and it appears that those which have been most successful have benefited from considerable external assistance. Research into factors leading to success in these programs, and perhaps support for particular community programs, is an area in which Australian agencies could provide meaningful assistance to the Philippines people.

Small-scale seedling nurseries

The assessment of impediments suggests greater availability of seedlings of Australian species – in particular, eucalypt seedlings – would lead to increased adoption. This, in turn, suggests a need to transfer seedling nursery technology for Australian species to the Philippines if welfare gains from research to date are to be maximised. While eucalypt seedlings are being produced at some locations, including nurseries of large forest companies, a more comprehensive network of small-scale nurseries would make the seedlings more readily accessible to potential adopters in farm and community forestry. It needs to be noted that this development could be in conflict with the desire of forest companies to sell more seedlings from their nurseries; although, if it led to greater interest in small-scale forestry their sales could actually increase.

Sources of finance for small-scale forestry

Another area where information is lacking is sources of finance to support farm and community forestry. Sources could include, for example, family and local money lenders, rural banks, special government funding, NGOs and other agencies (as donations or equity sharing), and foreign aid. Considerable information exists about rural credit in developing countries, but not much which specifically concerns such a long-term investment as forestry.

Redevelopment of a timber industry following extensive land clearing

A more generic study of timber industry development could be carried out, which might subsume some of the above research areas. The rationale would be that, although there is a dire need for reforestation and research has shown that timber trees (including the Australian species) can grow spectacularly, the level of plantings remains low and there is continued depletion of coconut plantations. Such a study could consider the wider implications of reforestation, in terms of local employment and other benefits, and watershed protection.

Research into timber marketing

Market research would appear to be an important component of any study concerned with forest industry development. This might involve structured interviewing of local timber merchants and larger operators about their timber sources, uses, technology and products, mark-ups, and views of the future of their industry.

Carbon credits and other supplementary payments to growers

There is considerable interest worldwide – including in developing countries – in the potential for trading in carbon credits. Internalisation of externalities (such as carbon sequestration, watershed protection and wildlife habitat) is potentially a mechanism to make forestry more profitable. However, designing a system to provide such credits raises many complexities, such as in the validation and monitoring of carbon storage and in ensuring that trees are not simply felled once credits are gained.

Research into management of buffer zones for national parks

Continuing degradation of native forests is a problem in the Philippines, and one means of overcoming deforestation has been to develop buffer zone on the margins of national parks. There appears to be scope for research into the management and use of buffer zones by government, farmers and indigenous occupants.

9. Concluding comments

Australian research has made an important contribution to forestry technology in the Philippines, and there is scope for further contributions to maximise the benefits from sunk expenditure. Australian tree species have the potential to play a major role – particularly for pulpwood in industrial forestry and for fuelwood and pole production.