Chapter 2

Literature Review

2.0 Review of Literature Related to this Study

The review of literature related to this study is presented in two sections. The first section details the literature describing the general characteristics of the neem tree, while the second section reviews the literature related to measure the investment potential of forestry investments.

2.1 Literature Related to the General Characteristics of the Neem Tree

2.1.1 Taxonomy

In the literature written on the Thai neem tree, two scientific names are used. The first, *Azadirachta indica var. siamensis Valeton*, is the primary name used in most of the references, and indicates that the Thai neem is considered a variety or sub-species of the Indian neem, *Azadirachta indica*.. However, Sombatsiri et al. (1995) dispute this. They propose that the Thai neem be given the new name *Azadirachta siamensis* and be regarded as a distinct species due to the fact that differences in morphological, anatomical, biological, phytochemical features allow clear differentiation between *A. siamensis* and *A. indica*..

Following in accordance to the taxonomic positioning given by Schmutterer (1995) for A. indica, the taxonomic position for *A. siamensis* is as follows:

Order	Rutales
Suborder	Rutineae
Family	Meliaceae (mahogany family)
Subfamily	Melioideae
Tribe	Melieae
Genus	*Azadirachta*
Species	*Azadirachta siamensis*

This paper will use *A siamensis* in any context in which the scientific name of the Thai neem may be needed. It should be noted here that even though there are enough unique features of the Thai neem to give it its own species classification, A *siamensis* and *A. indica* are still extremely similar. Moreover, both species can be found growing in Thailand, and for the most part could be used interchangeably in this research study. This is also true in regards to the research done on neem. In fact, the majority of the recent research on the Thai neem still treats it as a sub-species of the Indian neem. This is important since the vast majority of all research work done out side of Thailand has focussed on the Indian neem.

A third species of neem tree, *Azadirachta excelsa*, can also be found in the Southern region of Thailand. *A. excelsa* has gained a great deal of attention over the last couple of years, because of its potential as a commercial timber species and as a possible alternative to planting rubber trees which have shown diminishing profit margins due to low rubber prices.

2.1.2 Common Names

The Thai neem tree has several different vernacular names used in Thailand. In the central Thai dialect it is known as "Sadao Thai" or "Sadao Baan" while in the Northern Thai dialect it is called "Saliam." In the southern dialect, the Thai neem tree is called "Kadao" or just "Dao" (Sombatsiri et al., 1995).

2.1.3 Geographical Distribution

2.1.3.1 Thailand and Neighboring Countries

Unlike the Indian neem tree which is believed to have originated in either India or Burma (Schmutterer 1995), the origin of the Thai neem is not known. Sombatsiri et al. (1995) suggest that it is indigenous to Thailand.

A. siamensis grows in most parts of Thailand except for the more southern regions of the country where higher rainfall amounts hinder its growth. The tree is most often seen in and around village settlements, on dams in rice fields, and has been planted extensively along the roadsides by the Thai Department of Highways.

Sombatsiri et al. (1995) report that the Thai neem tree also occurs in parts of Southern Laos and western Cambodia. Dr. Klaus Ermal, an expert on the neem tree who during the period of this study was working for the Department of Agriculture in the Division of Agricultural Toxic Substances, also related that he had seen *A siamensis* and possible sub-species of the tree during his trips to Burma.

2.1.3.2 Global Distribution of the Neem tree

Outside of Thailand, the primary species of neem being propagated is the Indian neem (Azadirachta indica). Although the Indian neem originated in either India or Burma, it has been propagated around the world by the Indian Diaspora and by scientists interested in benefits of the neem tree. Table 2.1 presents a list prepared by the Deutsche Gesellschaft Für Technische Zusammenarbeit (GTZ) (1996) of all the countries where the Indian neem is known to have been planted, and the approximate number of trees in each country.

2.1.4 Ecology

The neem tree, both *A. siamensis* and *A. indica*, has the ability to grow in varying climatic and soil conditions.

2.1.4.1 Temperature

Schmutterer (1995) and Sombatsiri (1997)[1] both report that the neem tree is a typical tropical / subtropical plant which lives in environments with annual mean temperatures between 21° and 32° centigrade, but can also withstand temperatures as high as 50° and as low as 4° Centigrade. However, the neem tree is frost sensitive, and temperatures below freezing may kill off young trees.

2.1.4.2 Rainfall Levels

Considered a sub-arid tree species, the neem tree has gained a reputation for being extremely drought resistant. Because of this, it has been promoted in many African countries, Saudi Arabia, and India (Ahmed et al., 1989). The ideal rainfall levels at which the neem tree will thrive fall between 400 and 1,200 mm. The neem tree can survive rainfall amounts as low as 130 mm provided there is access to ground water. Rainfall amounts up to 2,500 mm can be tolerated with good soil drainage, but

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[1] See Sombatsiri (2540) in the Thai language references.

amounts in excess of 3000 mm per year hinders growth and fruit yields. In addition, extremely water saturated soils and standing water cause the tree's taproot to rot, eventually causing the death of the tree (Sombatsiri, 1997; Schmutterer, 1995; and Phuriyakorn[2], 1993).

[2] See **Phuriyakorn (2526)** in the Thai language references.

Table 2.1 Global Dispersion of the Neem Tree

Countries/ Regions	Occurrence of Neem Trees		
	> 1.0 Million	0.1 – 1.0 Million	< 0.1 Million
South Asia:	**25 – 35 million neem trees**		
India	+		
Sri Lanka	+		
Myanmar	+		
Pakistan	+		
Bangladesh	+		
Nepal		+	
South-East Asia:	**1.5 – 2.5 million neem trees**		
Indonesia		+	
Thailand	+		
Malaysia			+
Philippines			+
Vietnam			+
China			+
West Asia:	**0.5 – 1.5 million neem trees**		
Iran		+	
Iraq			+
Qatar			+
Saudi-Arabia		+	
Yemen		+	
East Africa:	**5 – 8 million neem trees**		
Egypt			+
Sudan	+		
Ethiopia	+		
Eritrea		+	
Djibouti			+
Somalia	+		
Kenya		+	
Tanzania		+	
Uganda			+
Southern Africa:	**1 – 2 million neem trees**		
Malawi			+
Namibia			+
Mozambique			+
Madagascar	+		
Mauritius			+
West-Central Africa:	**25 – 35 million neem trees**		
Mauritania		+	
Senegal	+		
Cape Verde			+
Gambia		+	
Guinea-Bissau		+	
Guinea		+	
Cote d'Ivoire		+	
Sierra Leone			+
Liberia			+
Ghana	+		

Table 2.1 continued

Countries1/ Regions	Occurrence of Neem Trees		
	> 1.0 Million	0.1 – 1.0 Million	< 0.1 Million
Togo		+	
Benin		+	
Nigeria	+		
Cameroon		+	
Mali	+		
Burkina Faso	+		
Niger	+		
Chad	+		
Oceania:	**0.1 million neem trees**		
Fiji			+
Papua-New Guinea			+
Caribbean:	**3.5 – 4 million neem trees**		
Dominican Republic	+		
Haiti	+		
Cuba		+	
Puerto Rico			+
Jamaica			+
Trinidad-Tobago			+
Montserrat			+
Antigua			+
Virgin Islands			+
Central & South America	**2 – 2.5 million neem trees**		
Mexico			+
Guatemala			+
Honduras		+	
El Salvador			+
Nicaragua	+		
Costa Rica			+
Panama			+
Columbia			+
Venezuela			+
Surinam			+
Guyana			+
Ecuador		+	
Peru			+
Bolivia			+
Brazil			+
Industrialized Countries	**0.5 million neem trees**		
USA			+
Australia		+	
Spain and Canary Islands.			+

Source: Deutsche Gesellschaft Für Technische Zusammenarbeit (1996)

2.1.4.3 Altitudes

Schmutterer (1995) states that the neem tree is usually found growing on plains and low-lying hilly country at altitudes from 50 to 1,500 meters above see level with the ideal range falling between 50 and 800 meters. Sombatsiri (1997) reports that growth rates above 1,000 m are not as good as those for lower altitudes, and suggests that decreased growth rates and low seed production at altitudes above 1,000 meters may be due to cooler temperatures and larger amounts of rain.

2.1.4.4 Soil Conditions

The neem tree tolerates a wide range of soil types, but does best on deep, well-drained sandy soils. Nevertheless, it will thrive on dry, stony, shallow soils and will even grow on soils having hard calcareous or clay pan at a shallow depth (Hedge, 1996). Neem likes soils which are slightly acidic with pH's ranging in value between 6.2 and 7.0. However, under certain circumstances the tree is able to grow with a pH as low as 5.0 and as high as 10.0 (Schmutterer, 1995 and Boonrert, 1990). Schmutterer (1995) also reports that the neem tree can grow in either alkaline or saline soils.

2.1.5 Botanical Characteristics

2.1.5.1 Bark

The bark of the Thai neem tree is relatively thick. The outer bark is dark gray or reddish brown in color (color differences might be due to differences in sub-varieties of A. siamensis), and the inner bark is reddish brown. The sapwood is grayish white, while the heartwood is dark reddish brown (Boonrert, 1990).

2.1.5.2 Leaves

Leaves of the Thai neem are medium to dark green. Normally, the Thai neem is a semi-deciduous tree having heavy foliage almost year round. Yet, during the dry winter season (January – March) the tree may drop its lower leaves only to sprout out new leaves after flowering (March – April) (Boonrert, 1990).

2.1.5.3 Flowering and Seed Production

The Thai neem generally starts producing flowers in the months of November or December and may continue to flower till March. The flowers are small and white having a mild fragrance, and are arranged in dense panicles (Boonrert 1990, and Sombatsiri et al. 1995).

After being pollinated, the flowers set fruit. Unripe fruit is light green in color, while ripe fruit is yellowish green. The fruit has a drupe shape that is approximately 1.5 – 2.0 cm in length and a smooth skin. Each fruit contains one to two seeds, but on occasion can contain as many as three seeds. Depending on the region and climate, the fruit ripens during the months of March to May (Boonrert, 1990). Unfortunately, at this time the yields of Thai neem fruits or seeds have not been recorded.

2.1.5.4 Growth Rate

The neem tree is a medium sized tree growing to 15 – 20 meters in height with a straight to semi-straight trunk, 30 – 80 centimeters in diameter, with spreading branches forming a broad open crown (Hedge 1996 and Sombatsiri et al. 1995). Schmutterer (1995) claims that very old trees on very suitable locations can grow to be 30-35 meters tall with diameters ranging from 80 to 110 centimeters (girth of 2.5 to 3.5 meters).

Actually, very little work has been published regarding the growth rate of the neem tree, and most of the data published is rather anecdotal like that given above. None of the literature published on the neem tree discussed or predicted annual growth rates. The only studies found that started to provide initial growth rate data came out of biomass research at a neem test plot in Ratchaburi province. Prasert[3] (1987), Suvith[4] (1988), Thoranisorn (1991), and Vicharn[5] (1993) all look at the stand density effects on the growth and form of the neem trees at differing ages at the Ratchaburi test site. The data collected for these studies provides a strong base from which to start growth rate research. However, the latest data collected (Vicharn 1993) represents only years seven and eight of the project. Much more time series data needs to be collected in order to make accurate long-term growth rate predictions.

2.1.6 Special Characteristics of the Sadao Tawai Variety of the Thai Neem Tree

Officially registered with the Thai Department of Agriculture as Sadao KhoPong, the Sadao Tawai variety of the Thai neem is identical to that of the regular Thai neem in every regard, except for one – flowering. The Sadao Tawai variety starts flowering in October instead of November or December. In addition to this, this variety of neem produces an inordinate quantity of flowers that exceeds that of a normal Thai neem by two or three times. Normally, a branch will only produce one batch of flowers, but if each subsequent batch of flowers is pruned away, the Sadao Tawai variety will produce two to three batches of flowers per branch annually (Thai Department of Agriculture document, May 1997, and Personal Communication with Vachira KhoPong, April 1997).

2.2 Literature Related to Measuring Forestry Investment Potential

Busby (1985) has written a guide for the FAO designed to assist in predicting the monetary costs and returns from growing forest tree crops. His framework for financial analysis of agroforestry projects encompasses the use of Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit / Cost Ratios (B/C ratio). However, he relies more on the analysis of a project's IRR more than that of its NPV or B/C ratio. In addition, his guide is written for those unfamiliar with the

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[3] See **Prasert (2530)** in the Thai language references.

[4] See **Suvith (2531)** in the Thai language references.

[5] See **Vichan (2536)** in the Thai language references.

terminology and principles of financial analysis, and is intended for those who have to make decisions about whether or not to invest in woodlots or other forms of forest plantations. Because of this, his guide is presented using decision flow charts instead of mathematical equations. For example, his method for calculating the approximate internal rate of return has the following steps:

1. Divide final net income by the initial expenditure:

$$\frac{\text{Final net income}}{\text{Initial expenditure}} = A$$

2. Divide final net income by the total expenditure:

$$\frac{\text{Final net income}}{\text{Total expenditure}} = B$$

3. Use these two income / expenditure ratios to find the range of IRR's for the given time length of crop rotation from a provided table.
4. Approximate the project IRR by averaging these two values.

$$\frac{(A+B)}{2} = \text{IRR}$$

For example, suppose that a particular forestry project has a five year rotation and that the approximate IRR values for "A" and "B" are equal to 21% and 16%, respectively. Thus, the approximate IRR of this project is (21+16)/2 which equals 18%.

Busby also presents another method for calculating a more accurate IRR using a projects NPV's. This method has the following steps:

1. Calculate the yearly net cash flows.

Year	Expenditure	Income	Net Cash Flows
0	(C_0)	(B_0)	$(D_0) = (B_0) - (C_0)$
⋮	⋮	⋮	⋮ ⋮ ⋮
n	(C_n)	(B_n)	$(D_n) = (B_n) - (C_n)$

2. Select two interest rates from a provided table that are close in value to the first method (16% and 20%).
3. Discount the net cash flows using both the high and low interest rates. This is done by multiplying the net cash flow in year n by the discount factor for the given rate of interest in year n.

For example, suppose the discount factor at 16% in year 0 is 1.00 and in year 1 it is .86. Thus, the net present value at a certain interest rate equals the discount factor for the interest rate multiplied by the value of the net cash flow. More simply put in equation form as follows:

NPV at x% = Net cash flow in year n × Discount factor at x% for year n.

It should be noted, however, that this will only work out right if the higher interest rate is high enough to produce a negative NPV.

4. Add the sums of the NPV's for every year for each rate of interest.
5. Calculate the IRR using the following formula:

$$\text{IRR} = \begin{pmatrix}\text{Lower rate of interest} \\ \text{used to derive NPV}\end{pmatrix} + \begin{pmatrix}\text{Difference between the} \\ \text{two interest rates used}\end{pmatrix} \times \left(\frac{\text{NPV at lower interest rate}}{\begin{matrix}\text{NPV at lower interest rate} \\ \text{minus NPV at the higher rate}\end{matrix}} \right)$$

Although Busby's approach proves to be more complex and time consuming than using regular mathematical formulas, his guide is not with out merit as he dedicates much of his book to the explaining the nature of both costs and benefits of forestry projects. He also suggests that indirect costs and benefits need to be included in the financial analysis, because some projects might not appear viable if only the direct costs and benefits are considered but may be more than viable if the indirect benefits are taken into account as well. The opposite can also be true.

Klemperer (1996) has written a textbook on forest resource economics and finance which covers a large number of topics in the economics of forestry projects. Of particular value to this study are chapter 4 "The Forest as Capital", chapter 5 "Inflation and Forest Investment Analysis", chapter 6 "Capital Budgeting in Forestry", and chapter 7 "Economics of Forestland and Even-aged Rotations" which all explain the methods and problems involved with appraising the worthiness of forestry investments.

Klemperer defines capital as any store of wealth yielding satisfaction to its owner. Under this definition, forest land can be classified as one type of capital asset, and therefore can be compared with other types of capital assets such as savings accounts, bonds, stocks, and certificates of deposit. In order to compare forestland with another type of capital asset, one must first ascertain the opportunity costs associated with investing in one or the other type of capital asset. To do this, Klemperer emphasizes the use of net present value, internal rate of return, and benefit / cost ratios in one form or another to analyze the feasibility and worthiness of forestry projects. Chapters four, six, and seven are devoted to explaining in-depth the use of Net Present Value, Internal Rate of Return, and Benefit / Cost ratios as they apply to forestry investments.

Since the income and asset value of forestry investments tend to increase with the inflation rate, chapter five therefore relates the necessity of including inflation in the calculations of NVP.

Waraporn (1991)[6] has written an economic analysis of three of the Forest Industry Organization's *Melia azedarach* Linn. plantations in the Northeastern region of Thailand. Her study employed the use of three economic appraisal methods i.e. benefit / cost ratio, net present value, and internal rate of return, to determine the financial returns and best rotation lengths for these three plantations given that each plantation represented a different site index with site I being of the best quality and site III the poorest quality. The Baht per cubic meter of price levels set for this study were 400, 450, 500, 550, and 600 Baht / cu. m. respectively, and the interest rates set forth were 9%, 11%, 13% and 15%. Using the three before mentioned price and interest rates to run the three economic appraisal methods, the study found that only site I showed benefit / cost ratios larger than one at several Baht / cu. m. price levels and interest rates. Site II only showed profitability at a log-price of 600 Baht / cu. m. and an interest rate of 9 percent. Sit III showed a loss at all levels of price and interest rates.

Miss Waraporn's study is of great value to this study for several reasons. First, *Melia azedarach* Linn. is in the same family as Azadirachta siamensis valeton

[6] See **Waraporn (2534)** in the Thai language references.

and they both show similar characteristics. Secondly, her study uses the benefit / cost ratio, net present value, and internal rate of return analysis methods to appraise the financial worthiness of the Forest Industry Organization's forest plantations. Thirdly, she also examined the sensitivity of the project's financial worthiness to different stumpage prices and interest rates. Therefore, her research provides a strong reference point for this study. However, a large part of miss Waraporn's study focuses on finding the best economic crop rotation length which is not congruent with this paper. In addition, her study does not specify for what the wood from these plantations was to be used. As such, it is difficult to determine whether the stumpage price levels specified in her paper could be adapted for use in the present study due to the fact that different end uses demand different stumpage prices.

Tongchai (1993)[7] has written a book on the financial benefits of planting Azadirachta excelsa (Jack) Jacobs which is in the same genus as Azadirachta indica var siamensis Valeton. His work covers all the costs and benefits of planting and maintaining Azadirachta excelsa plantations for timber production, and then compares these results with those associated from planting rubber tree plantations. The results point to the fact that planting Azadirachta excelsa shows a higher rate of return than planting rubber trees. However, his study does not include the intermediate profits gained from the sale of the tree's seed, which also can be used to produce insecticide just like that from Azadirachta indica and Azadirachta indica var siamensis seeds.

Tongchai's study is extremely beneficial towards the present study in that the production and maintenance methods, which he outlines in the book, can be transferred over to the use of Thai neem plantations. In addition, the cost figures associated with the planting and maintaining of an Azadirachta excelsa plantation can be used as proxy figures for Thai neem plantations with only one exception, that being the cost of collecting the seeds for sale must also be included into the cost figures. Unfortunately, the income figures presented cannot be used as proxies for Azadirachta indica var siamensis due to the fact that Azadirachta excelsa is a much

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[7] See **Tongchai (2536)** in the Thai language references.

faster growing tree. Thus, the timber production figures between the two years would not be in agreement. Furthermore, no literature comparing the wood qualities between the two species seems to have been written. As a result, it is unclear whether the log-price per cubic meter of wood for Azadirachta excelsa can be used as a proxy for Azadirachta indica var siamensis or not.