Chapter 6
Conclusion and Policy Recommendations

6.1 Major Findings

6.1.1 Summary of Findings

6.1.1.1 The neem tree, neem-based products, and potential markets.

Chapters two and four review the literature published regarding the physical characteristics of the neem tree and the products made from its various parts respectively. The Thai neem tree, *Azadirachta siamensis*, is a hardy tree species that grows throughout Thailand, though fewer trees grow in the South as compared with the Northern, Central, and Northeastern regions of the country. It can grow in areas of reasonably low rainfall, but cannot withstand standing in water for long periods of time. Starting to flower in the second or third year, the neem tree starts producing measurable amounts of flowers and seeds in the fifth year of its life, and reaches maximum sustained levels in approximately the tenth year.

A larger variety of products can be produced from the seeds and timber of the neem tree. The potential markets for neem-based products, both domestically and internationally, appear strong.

6.1.1.2 Comparison of the Financial Benefits Results between the Sadao Thai and Sadao Tawai Plantation Investments.

The analysis results given in chapter 5 show that the Sadao Tawai investment project has a greater potential net present value (NPV) than that of the Sadao Thai plantation investment project. Based upon these results, an investor with capital enough only to invest in one project type would maximize his investment returns by choosing the Sadao Tawai investment project.

6.1.1.3 Comparison of the Economic Benefits between Sadao Thai and Sadao Tawai Tree Farming.

Although the financial benefits from the Sadao Tawai tree farming show greater potential than that of Sadao Thai tree farming, the same does not appear to be true for the national economic benefits that could be achieved through each type of investment. Sadao Tawai tree's major product is its flower, which is consumed primarily domestically in an unprocessed form. Outside of the seasonal employment generated for flower collecting and tree pruning, the prospects for other economic linkages, either forward or backwards, appears limited.

This, however, is not the case for Sadao Thai plantations. The seeds collected from these plantations can be made into a large variety of different products such as insecticides, fertilizers, soaps, cosmetics, medicinals, etc. While at the same time, the timber can be used in many different industries as well. The net result could be the generation of a number of new industries related directly or indirectly to the processing of these raw materials into value added goods. The development of these new industries could also possibly create a broad range of forward linkages.

In addition to the generation of new industries related to the production of neem based products, more subtle economic benefits could be reaped from reduction in the use of highly poisonous synthetic insecticides and the negative health effects they have on the farmers, who use them, and the people who unknowingly digest them. The economy as a whole could also benefit from partially substituting neem-based fertilizers for imported chemical fertilizers.

6.1.1.4 Summary of the Results of the Sensitivity Analyses .

6.1.1.4.1 Sadao Thai Sensitivity Analysis Results

Standard investment analyses, i.e. investment analyses including only the internal sensitivity analyses described in chapter 3, were most sensitive to the inclusion of the 50,000 Baht land purchase showing a viability of 55.6% for the "A" investment scenarios and 52.8% for "B" investment scenarios. These were followed in sensitivity by investments including the 5,000; 4,000; 3,000; 2,000 and 1,000 baht opportunity costs respectively.

The inclusion of the Thai Government Afforestation Subsidy showed positive results, however these positive results were very minimal. At best, they only improved the Sadao Thai Investment viability by approximately three percent.

In regards to the external sensitivity analyses conducted, investment viability was most negatively sensitive to the 50% decrease in the estimated wood volume, followed by the inclusion of the 10% inflation hedge, 25% decrease in estimated wood volume, and reduction in thinning price from 80 to 50 Baht/tree. The investments were all positively sensitive to an increase in the per tree thinning price from 80 to 175 Baht/tree. At this thinning price all 36 "A" and "B" normal investments were viable.

6.1.1.4.2 Sadao Tawai Sensitivity Analysis Results

The standard Sadao Tawai investment analysis showed were equally sensitive to the inclusion of the 50,000 Baht land purchase and the 5,000 Baht/year opportunity cost showing a over all viability of 66.7%. This was followed in descending order by the 4,000; 3,000; 2,000 and 1,000 Baht opportunity costs respectively.

Only one external sensitivity analysis was conducted for the Sadao Tawai anal project analysis, which was the inclusion of a 10% inflation hedge. The results showed only minimal sensitivity for the investment scenarios including the 4,000; 3,000; and 2,000 Baht/year opportunity cost. All other scenarios remained unchanged.

6.1.1.5 Further Information and Data Needed to Better Determine the Financial and Economic Feasibility of Neem Tree Production.

Due to a large lack of published and/or quantified data, the results of this thesis are based to a large degree on guestimates. Scientific research must be conducted in Thailand into the agronomy of the neem tree in order to provide more detailed information that can be used to better calculate potential financial returns from neem seed and timber production.

Specific questions that need to be answered regarding Sadao Thai plantations are as follows. Each question is important with no question taking priority over any

other. In fact, all of these questions are inter-rated with the results of one affecting all of the others.

What are the annual growth rates for trees located in different parts of the country, and how are these growth rates affected by soil and atmospheric conditions? Having answers to these questions would help to develop ideas of which part of the country should be best targeted for neem plantation promotion.

What is the average annual, seed production rate for each year of neem tree's life? Knowledge of average annual, seed production would allow for more accurate prediction of financial returns from seed sales. Knowledge of this would also point out where the economies of the neem lie more strongly, i.e. with seed production or timber production.

At what year does the neem tree reach maximum seed production, and how long does it maintain this before starting to decline? If the economics of the Sadao Thai tree lie in seed production, it is very important to know when seed production will begin to drop off as it will signal the time to clear cut the trees and replant the plantation. Knowledge of the neem tree's seed production length could also aid in predicting what volume of timber will be harvested at the end of the plantations life, thereby increasing the investor's ability to predict overall financial returns.

How is seed production affected by soil and atmospheric conditions? The predictions made in this study made the assumption that the neem tree grows well almost all soil types except waterlogged soil. Yet, no research has been conducted on how soil quality effects seed production output and quality. Both of these are important factors that could easily promote or hinder a plantation's financial viability.

What tree spacing will maximize both seed and timber production? In order to take part in the government afforestation subsidy program, two hundred trees must be planted per rai, which means that the trees must initially be planted with a 4x2 spacing. In year five after receiving the last subsidy payment, the plantation should be thinned out to promote greater seed and timber production. The major question, however, is what should the new spacing be? Ideally, keeping the trees close together would maximize timber production, while separating the trees as much as possible would maximize seed production. The appropriate spacing that would maximize both types of production at the same time needs to be found. And once again, knowledge

of the final number of trees per rai and the yearly seed production amount, is extremely important to predicting overall financial viability of the project.

How effective is the application of fertilizer in increasing seed and timber production? This study also made the assumption that applying fertilizer would boost seed production and timber growth rates. Yet, with out hard evidence to prove this, over applying fertilize may hurt the project more than help it.

The Sadao Thai investment analysis only calculated the financial returns for bottom four meters of the tree. Yet, since these trees can grow to heights of 15 – 30 meters, the amount of harvestable wood may have been greatly under-estimated. Hence, an accurate tree volume estimation curve for the neem tree needs to be developed by professional foresters for use by financial analysts. In addition to this, there is a need to determine whether trees of different ages would garner the same price per cubic meter or not, as it could potentially affect the optimum rotation length. The results of this study tended to point to shorter rotation lengths when the economics of the neem tree leaned toward timber production. But this might have been the result of a single timber price for all age groups. If 15 and 20 year old trees only received a price of 1,000 baht per cubic meter while 30 and 40 year old trees received 5,000 and 10,000 respectfully, the results might show that the longer investment period was the most optimal one.

The following are specific questions that need to be answered regarding Sadao Tawai plantations. They are basically identical to those questions just raised regarding the Sadao Thai plantations, and all are of the utmost priority if Sadao Tawai plantations are to be at all promoted.

What is the average annual, flower production rate for each year of neem tree's life?

At what year does the neem tree reach maximum flower production, and how long does it maintain this before starting to decline?

How do soil and atmospheric conditions affect flower production? It is worth noting here that the Sadao Thai and the Sadao Tawai tree are both of the *Azadirachta var siamensis* species, yet they are not the same. This points to bio-diversity with in this species of neem tree, and it raises the question of how the Sadao Tawai variety came into being. Did it have anything to do with the soil and climatic conditions of

Chiang Mai, or was it simply a lucky mutation? This question spawns yet another question. If soil and climatic conditions lead to this mutation, what are the odds that some one planting Sadao Tawai trees would end up with trees that produce a limited amount of flowers but a substantial amount of seed? Or what if a farmer plants Sadao Thai trees with the idea harvesting seeds and timber, but finds that his trees are producing large amounts of flowers but little in the way of seed? In such a scenario, what should the farmer do, and how much of this type of situation would be due to genetic diversity and how much of it would be due to climatic conditions?

What tree spacing will maximize flower production? Mr. Vachira KhoPong recommended a 6x6 meter spacing between his Sadao Tawai trees. He has the most experience with this variety of neem tree, but nevertheless no research has yet been conducted into whether different spacings would give higher yields. Since the economics of the Sadao Tawai tree fall solely on flower production, maximizing flower output translates directly into maximizing income. Hence, research into plantation spacing is extremely important.

How effective is the application of fertilizer in increasing flower production? What needs to be deciphered from fertilizer usage data is what is its marginal return to investment profitability, i.e. at what point does the application of fertilizer no longer yield a profit larger than the cost of the fertilizer itself?

Because the Sadao Tawai subspecies has only recently developed, very little information and data has been collected regarding it. Moreover, since the oldest established plantation is only seven years old, it is difficult to even guess what the plantation will look like after 15, 20, 30, and 40 years. Nevertheless, the more data about this interesting subspecies of *Azadirachta Siamensis* can be collected, the better able we will be to predict its long-term prospects.

6.2 Policy Recommendations

The results of this thesis clearly find that there exists a strong economic potential for neem tree production. The Thai government has already started promoting the use of neem-based insecticides, but has not yet taken the steps needed to support the demand being generated by promoting neem tree production.

The Thai government can promote neem tree plantations in several ways. First, the government can conduct more research into the agronomy of the neem tree, and then quickly disseminate it out to farmers and interested investors. With greater knowledge of the tree's agronomy, investors could use the results of this study to anticipate whether the intended plantation investment would be financially feasible or not. Moreover, interested individuals who are less willing to take a "let's plant and see what happens approach," may decide to set up neem plantations once more in-depth knowledge of the tree's agronomy is available.

Second, the government can support private and government research into the development of a variety of neem-based products for both domestic and global consumption. By continuing to develop a market for neem-based products, the government can be assured that more private companies will look to invest into supplying the demand for both raw materials and finished products. In terms of this study, a strong demand for neem based products would surely push the short term seed price up to the highest seed price level, which showed strong potential at every seed/wood price combination level. And of course, if farmers can see others making money by planting neem trees and collecting the tree's seeds, they will strongly be inclined to follow suit.

Finally, the government can continue to provide a financial incentive to plant neem trees through its afforestation subsidy program. Even though the results of this study show that the afforestation subsidy only marginally affected the financial viability of the neem plantation, it may provide an important psychological incentive to poorer farmers to make the longer-term investment. Poor farmers who only wanted the government subsidy and knew little or nothing about the true potential of the Thai neem tree, have been the ones who have planted many of the neem trees in the Northeast in recent years. Therefore, the continued use of the subsidy may be one method to attract poorer farmers to the idea of setting up small-scale neem plantations on poorer quality farmland.