



Growing Neem Trees in Australia

A Feasibility Study

**A report for the Rural Industries/Land & Water
Australia and Forest and Wood Products
Research and Development Corporations
Joint Venture Agroforestry Program**

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Foreword

Neem trees grow naturally in hot and seasonally dry tropical areas of the world. The growing of neem trees and/or use of neem based insecticides have often been promoted in Australia and some plantation production has been initiated.

This publication provides a brief review of the potential for the development and application of neem production systems in Australia, with focus on low rainfall areas. The report covers the production, harvesting, ingredient extraction and the market for neem products. The aim is to provide a review of the many factors that influence the technical and economic viability of neem as a future tree crop in Australia.

The issue of whether neem trees can be used to lower watertables in the low rainfall temperate areas of Australia is also addressed in the review.

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The report, a new addition to RIRDC's diverse range of over 700 research publications forms part of our Joint Venture Agroforestry Program which aims to integrate sustainable and productive agroforestry in Australian farming systems.

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Peter Core

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Abbreviations

JVAP	Joint Venture Agroforestry Program
NRA	National Registration Authority
QDNR	Queensland Department of Natural Resources
QDPI	Queensland Department of Primary Industries
RIRDC	Rural Industries Research and Development Corporation
TGA	Therapeutic Goods Administration
TGAC	Technical Grade Active Constituent
US EPA	United States Environment Protection Authority

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Executive Summary

The neem tree (*Azadirachta indica*) has been known for a very long time to exhibit insecticidal properties. It grows naturally in the hot and seasonally dry tropical areas of the world.

The active ingredient that has received most attention is azadirachtin, found in many parts of the tree, but concentrated in the seed. The seed has become the main focus of interest in attempts at commercialising this tree species.

The key challenges being faced are

- lower the costs of harvesting of the seeds by means other than using hand labour as in India,
- extract the azadirachtin from the seed in a cost-effective manner so that it remains stable with few toxic metabolites, so enabling it to be used in commercial products,
- demonstrate the efficacy of products in relation to specific insect pests and crop types and situations, and
- gain approval for use of neem products from the regulatory authorities.

The biggest challenge is to develop a production system that allows profitable production and distribution of formulated products. A particular focus of the current review is to assess the prospects for neem trees in the low rainfall areas of Australia where agroforestry that targets commercial production as well as providing a sustainability function is required.

The market for neem based products in Australia is restricted due to the difficulty of registering azadirachtin in Australia, questions of efficacy, and the likely price required to cover the costs of production. There is potential for the market to grow due to the preference for natural insecticides, both in Australia and elsewhere, but the relative costs of production of neem seed in different locations could work either for or against production and/or processing in Australia.

Quality neem seed in commercial quantities could be produced from Australian plantations for processing in Australia in the future if the production economics were favourable and an extraction operation were to be established here. At present neither of these conditions appear likely. The lack of Australian registration of products currently works against any processing operation in Australia, either from seed produced in Australia or elsewhere.

If Australian neem seed producers were to supply export seed markets they would face competition from existing producers, as well as from other sizable plantings of neem trees taking place or planned in other countries including southern China, Florida and Haiti. Further analyses incorporating extraction, manufacturing and marketing operations could be useful to assess the likely economic viability of a prospective growing operation under present conditions.

A form of extensive production (without irrigation and fertiliser) but utilising mechanical harvesting would be intuitively attractive provided growth rates and seed yields would be high enough to justify the overall investment. As mentioned previously, the economics of harvesting could work against low yielding extensive plantings.

It is unlikely that seed could be produced and harvested economically in the West Australian wheat belt, unless selection for high azadirachtin content of the seed in that environment were successful. It is more likely, taking into account commercial considerations only, that plantations as far north in Australia as possible, and with irrigation available, would be more likely to produce seed in a competitive manner with other parts of the world.

The principal findings from this brief review are:

- There are currently no neem products registered for therapeutic or agricultural or veterinary use in Australia, despite a number of attempts in the past and the long history of the tree. Hence, there is no current market for azadirachtin extracts in Australia.
- The commercial world market for neem extracts and products is unknown but is thought to be relatively small but growing.
- Extraction processes, residues from extractive processes and the breakdown of metabolites from azadirachtin are constraining registration of neem chemicals in Australia.
- There is a high and growing demand for natural and 'safe' insecticides. However, despite having shown to be effective in selected instances, there are some questions over the broad-scale efficacy of azadirachtin based products, compared to existing chemicals used.
- Currently seed can be produced at lower cost overseas than that likely to be incurred in Australia largely due to harvesting methods and the cost of labour.
- For a competitive industry to be developed in Australia, it is likely that much effort would need to be invested in selection and clonal propagation, cultural practices, harvesting methods, and extraction processes.
- Neem trees may have to be produced under intensive conditions in Australia in order to obtain the seed and azadirachtin yields, and low mechanical harvesting costs, necessary to make an extraction and marketing venture financially attractive.
- There are a number of factors currently operating against commercial production in Australia. Some of these are being tackled by the private sector and significant enthusiasm still exists.
- While the neem tree is reasonably well adapted to different environments and may be useful in drawing down water tables, little information is available on how it might produce in terms of growth rates, seed production and azadirachtin content in cooler and wetter winters and drier summers than experienced in its natural habitat.
- According to the outputs from the PLANTGRO model, the ideal average temperature for the neem tree is 33 degrees C. It will grow down to 10-14 degrees C. The tree will not tolerate much above 53 degrees.
- Overall, if the neem tree is to be commercialised in Australia, it is more likely to be grown in the more favourable conditions in northern Australia, rather than in more temperate conditions.
- If RIRDC were to support an R&D program on neem, areas for R&D would need to include the economics and potential economics of production, selection, clonal propagation, planting densities and cultural practices such as irrigation needs and fertiliser requirements, harvesting methods, extraction processes and testing and data assembly for registration. Specific priorities would need to be developed in conjunction with private interests pursuing neem development.

1. Introduction

This study was designed to assess the potential for the development and application of neem tree production systems in low rainfall areas of Australia from the point of view of technical and economic viability, as well as resource sustainability. The brief review commences with some background information on neem, some of the reasons it has been of considerable interest to many groups around the world, and why it continues to attract attention (Section 2).

The markets for products emanating from the neem tree are briefly reviewed in Section 3. This includes markets for what is usually considered the most valuable chemical component (azadirachtin) that can be extracted from the seed. Section 3 also includes a brief account of technical and regulatory considerations as they affect the market and marketing.

Australian production of neem seeds is addressed in Section 4 including current plantings and likely production and processing systems. It concludes by considering the viability of an industry in Australia.

Section 5 provides a summary of main findings of the brief review, including what actions RIRDC and the Agroforestry Joint Venture might consider in terms of their respective roles in supporting new industry development and agroforestry ventures.

2. Background and Overview

The neem tree (*Azadirachta indica*) has been known for a very long time to exhibit insecticidal properties and has been used in India for centuries for various domestic and health purposes. It grows naturally in the hot and seasonally dry tropical areas of the world.

The active ingredient that has received most attention is azadirachtin, found in many parts of the tree, but concentrated in the seed. The seed has become the main focus of interest in attempts at commercialising this tree species. Modern science has been applied to the neem tree since the 1950s with most focus on its content of azadirachtin. The search to develop new chemicals and the use of natural substances for pesticides has been emphasised in the past 20 years due to the development of resistance to traditional pesticides. Further, the 'natural' product trends in society have been encouraged by perceptions that the use of many 'synthesised' agricultural and veterinary chemicals can create human health problems.

The opportunity to grow neem trees in Australia has appeared to many to be a rational pursuit and worthy of consideration, provided useful products that are financially viable to produce can emanate from the tree. Some also have considered the tree may be used for plantings for environmental purposes in Australia.

Neem has experienced ongoing development as an insecticide over the past 20 years, particularly in the USA and more recently in Australia and other countries. There have been limited successes and a series of difficulties encountered over this period. Components or extracts from the tree have not yet become a mainstream insecticide. However, there remains in Australia and elsewhere, a number of protagonists that are endeavouring to register neem products and strengthen the commercial dimensions of neem tree growing and marketing of neem products.

Although there is a ready supply of neem seeds available from India and other locations, they contain varying levels of active ingredient. Past and current attempts have been made to explore the potential to select trees that have higher concentrations and to grow the tree in more favourable conditions to improve yields.

Other challenges faced are to:

- lower the costs of harvesting of the seeds by means other than using hand labour as in India,
- extract the azadirachtin from the seed in a cost-effective manner so that it remains stable with few toxic metabolites, so enabling it to be used in commercial products,
- demonstrate the efficacy of products in relation to specific insect pests and crop types and situations, and
- gain approval for use of neem products from the regulatory authorities.

The biggest challenge is to develop a production system that allows profitable production and distribution of formulated products. A particular focus of the current review is to assess the prospects for neem trees in the low rainfall areas of Australia where agroforestry that targets commercial production as well as providing a sustainability function are of great interest to the Joint Venture Agroforestry Committee.

3. The Market for Neem Tree Products

3.1 Product Markets

Products that might emanate from the neem tree include extracts from the seed, the oil and the residual cake. The neem tree can also produce wood which is very hard and is termite resistant, and of course, as with other trees, may be used to enhance the environment in some situations through improving soil and groundwater balance, carbon sequestration etc.

Neem oil can be extracted from the seed of the neem tree either through cold pressing or solvent extraction processes. Neem oil contains only small amounts of azadirachtin, but is claimed by many to have positive effects in both therapeutic and agricultural and veterinary uses. Currently there is a small amount of neem oil imported into Australia and used in various applications including the control of head lice, insect repellants and agricultural and veterinary applications. However, no neem oil products are currently registered for sale in Australia. Such unregistered products are probably legal to use provided claims are restricted, and other uses may be allowed under legislation in some states.

The residual cake after oil is extracted from the seed can be used as an organic fertiliser as it has a high protein and nitrogen content. Some cake has been imported from India into Australia from cold pressed seed.

Variable concentrations of azadirachtin are present in the seed and can be extracted using solvents. It is understood that the concentration of azadirachtin in the seed does not vary markedly during maturation. Concentrations of azadirachtin in the seed vary from lower than 0.4% to up to 1% (Simpson, 1995). Azadirachtin can be unstable and can break down when exposed to UV light. Hence the extraction and stabilisation process can be quite critical in ensuring product efficacy.

There are several products registered in the USA. For example, the neem-based crop pesticide 'Margosan-O' is registered by the US EPA, and commercially available in the US. The US registration process for this neem-based crop pesticide product has been partially documented, and some information could be gleaned from the US EPA report.

There is no product registered for therapeutic or veterinary use in Australia. Trials carried out by the QDPI in Australia in the early 1990s suggested that some pests of vegetables could be controlled by high concentrations of azadirachtin but that some pests of ornamentals could be controlled with lower concentrations (Drew, 1992). Later trials by QDPI concluded that "unless there is a specific need for an insecticide with low mammalian toxicity or a targeted IPM program, azadirachtin is inferior to synthetic standard insecticides in single application, nursery crop situations. Azadirachtin is too slow, too costly and too weak compared to other products on the market" (Simpson, 1995).

It is understood that the principal reason azadirachtin is not currently registered in Australia is the uncertainty as to the potential toxicity of some of the metabolites that may be derived from the products. Efforts on registration are continuing.

There are also suggestions that other parts of the neem tree such as the leaves and the bark contain insecticidal and therapeutic properties and that it is the range of chemicals, rather than azadirachtin alone, that is behind the insecticidal properties of neem. In fact, the only significant neem plantation in Australia currently markets powders and oils from various tree materials from the north Queensland plantation (Connor Horley, pers comm, 2000)

The reality is that, despite being available for a long period, neem oil or azadirachtin based products have not captured any significant share of the world personal health care, pesticide or veterinary markets, and no product is currently registered in Australia. Registration would logically make a difference to the market size in Australia and it is to this process that we now turn.

3.2 Technical and Regulatory Considerations

Factors that have worked against the registration of neem products in Australia in the past include both the technical difficulties associated with product registration as well as the cost and time required.

The Therapeutic Goods Administration (TGA) is the Commonwealth body responsible for the assurance of quality, safety and efficacy of therapeutic goods within Australia. The regulations applicable to the registration of therapeutic goods are contained within the *Therapeutic Goods Act 1989*. The TGA is responsible for the administration of this legislation. The National Registration Authority (NRA) is the Commonwealth body responsible for the evaluation, registration and surveillance of all agricultural and veterinary chemical products in Australia. The regulations involved with the registration of agricultural and veterinary chemicals are defined in the *Commonwealth Agricultural and Veterinary Chemicals Code Act 1994*.

Registering a new chemical product in Australia either through the TGA or the NRA is often a long and involved procedure. Registration of neem based products could be achieved if the following conditions were met:

- The neem-based ingredients are able to be adequately characterised
- Neem based product formulations maintain adequate stability levels
- Neem based products are scientifically proven to be non-toxic
- Neem based products are proven scientifically to be effective in the control use claimed
- Neem based products are scientifically proven not to produce toxic residues, are safe to use and do not impact negatively on the environment.

Characterisation of the Active Ingredient

The first stage involved in the registration of any new chemical product with the NRA is usually to positively identify and characterise the active ingredient. Chemical characterisation is useful to ensure one specific substance with documented characteristics is identified for use in future product manufacturing.

Chemical characterisation of the active ingredient(s) and other components of the Technical Grade Active Constituent (TGAC) must include isomer ratios, if applicable, and must give the minimum content of active ingredient(s) in the TGAC. Also the nomenclature of each component including chemical and physical properties must be provided as detailed in the NRA Requirements Manual. It is important that the toxicological studies be carried out with a TGAC that is similar to, if not the same as, the substance to be marketed.

Some TGACs may be given an 'exemption' whereby the TGAC is excluded from the requirements of NRA approval. The main purpose of this 'General Exemption' list is to exclude certain chemicals from the full requirements for data approval, particularly where the chemical has been in common use for many years and has not been primarily developed as an agricultural chemical. In essence, for chemicals on the list, the general requirements for data provision for active constituents give way to specific requirements for data provision for products on a case by case basis depending on the type of chemical active and how much is generally known about the chemical (NRA, pers comm, 2000).

The NRA inherited the TGAC exemption list when it was established, and there are a number of chemicals on the list for which significant amounts of data would still be required. Neem is such a chemical and, at present, certain data on the technical neem still have to be supplied as part of the application for product registration. The NRA is currently reviewing the category of TGAC exemption, and the exempt status of neem is under consideration (NRA, pers comm, 2000).

Efficacy Testing

Scientifically produced efficacy data is required by the NRA in the registration process. Comprehensive data are required showing results of field-scale trials that indicate the end-use product is effective for the purposes claimed. Data should be produced following the principles of an established scientific method.

Testing for Stability

Stability testing is necessary for two reasons. Firstly to determine if a new product will retain its efficacy, and secondly to determine if metabolites of the active ingredient are dangerous. If a product is not highly stable, the NRA may grant permission for an expiry date to be placed on the product labeling. Also, the NRA is flexible with regard to the level of degradation of the active ingredient that would be permitted. For example, if significant degradation of the product occurs but the product is proven to remain safe and effective, the NRA may permit product registration to proceed.

It is understood that there may still be some uncertainties regarding the breakdown metabolites of the azadirachtin extracts. To date it is the lack of a complete toxicological database for neem extracts/azadirachtin which has precluded product registration (NRA, pers comm, 2000).

Differences in extraction methodology associated with the US product compared to products proposed for registration in Australia have made it difficult to validly extrapolate the toxicological data base used to support the US product registration. The TGA advise that there are considerable differences in the chemical composition of the various neem preparations (neem seed oil, neem oil extract, neem seed cake extract, pure azadirachtin, azadirachtin derivatives etc) and toxicology studies on any one of these are not necessarily applicable to any of the others (TGA, pers comm, 2000).

Toxicity Testing

While chronic and reproductive tests may not be necessary, tests for acute toxicity, sub-chronic and special toxicity are most likely to be required. The Department of Human Services and Health advise the NRA regarding all health aspects, toxicity and residue implications of a new active ingredient.

Product Safety Assessment

Neem-based products are believed to be harmless to humans as a result of extensive traditional use of neem products overseas. Therefore, the safety aspects are not likely to be very important to the regulatory authorities. If toxicity tests conducted in the registration process indicate a neem-based product is non-toxic, an exemption from safety testing could be submitted to the NRA for consideration. However, material safety data sheets would be required by the NRA for each new product line to be registered.

Environmental Testing

Environmental assessment of new chemical products is undertaken by the Environment Protection Group within Environment Australia. Information needs to be submitted to determine:

- the degree of environmental exposure,
- the toxicity of the chemical to aquatic organisms, terrestrial organisms, birds and desirable vegetation (as applicable), and
- the overall environmental hazard of the chemical including details on both exposure and toxicity.

Details are required regarding the physiochemical degradation of the neem-based substance, biodegradation, mobility, field dissipation and accumulation or metabolism details. Directions for the application and disposal of the chemical are also required for evaluation.

With regard to environmental toxicity testing, the Environment Protection Group may consider that the toxicology evidence based on years of use in a traditional sense in India may be more relevant to the public health/occupational health assessment. Toxicological evidence often cannot be used directly to draw conclusions as the responses of mammals and invertebrates can vary widely due to a

different mode of action. The Group is, however, able to use any knowledge gained from the literature or previous applications in making its assessment.

There is the likelihood that neem trees could be spread by birds from plantations to other nearby environments and this might be a matter for further investigation. Some controversy regarding this issue is already manifest in relation to the north Queensland plantation.

To date no applications to register neem-based products in Australia have been considered to contain sufficient or adequate information from a public health perspective.

3.3 Market Size

It would be very difficult to estimate the market size of any neem based insecticide. Without registration the market size will remain very small in Australia. If registration is achieved (and it is understood that further registration applications have been made), the market size in Australia would inevitably grow from its current small base.

The current size of the world market for neem based products manufactured in the USA (where some products registrations have been made) has not been estimated in this brief review due to resources available. Nor have trends in that market been compiled.

Apart from registration considerations, the other factor that will determine the market size for azadirachtin based products, is its general efficacy and the range of uses to which it can be effectively and economically applied. Azadirachtin does not work through a 'knock down' action. It takes time to reduce insect numbers and therefore may have to be used in conjunction with other insecticides and control systems.

Apart from efficacy considerations and the scope for use of products (for particular insects and particular crops), the market size is likely to be significantly influenced by the price required to cover costs of acquiring neem seed, extracting and stabilising the azadirachtin, and manufacturing and marketing the product. If the price of azadirachtin products are significantly higher than alternative insecticides, the market could be restricted to uses such as where 'natural' insecticides are specifically required (e.g. food handling areas) or such as strategic applications within an IPM program. Even so, the market sizes could be significant.

On the other hand, if resistance to the more traditional insecticides increases, or they are perceived even more strongly than currently to be having an adverse effect on human health and the environment, the demand for 'natural' insecticides could increase and azadirachtin based products may be well able to command a price consistent with its cost of production.

3.4 Conclusion

The market for neem based products in Australia is restricted due to the difficulty of registering azadirachtin in Australia, questions of efficacy, and the likely price required to cover the costs of production. There is potential for the market to grow due to the preference for natural insecticides, both in Australia and elsewhere, but the relative costs of production of neem seed in different locations could work either for or against production and/or processing in Australia. It is this issue that is considered next.

4. Australian Production of Neem Seed

The potential being assessed in this brief report is whether a neem-based internationally competitive broad acre industry could be developed in Australia. Current plantings in Australia are briefly reviewed and the potential for developing an efficient and competitive production system explored.

4.1 Current Plantings of Neem Trees in Australia

Documented analysis of the neem tree species and the climatic and geographic conditions favouring plant growth indicate the neem tree is suited to Australian conditions. Most interest has been in Queensland where the tree was seen to have considerable potential in hot dry areas of northern Queensland (Jenkins, 1989).

There are a number of neem trees planted in Australia, some in a plantation formation. Neem trees were established in the 1980s at a QDPI Research Station at Ayr in the Burdekin region of north Queensland. A serious investigation partly funded by the Rural Industries Research and Development Corporation (RIRDC) was mounted in the 1990s and involved the QDPI, Neemoil Australia and Comalco. This investigation utilised the neem trees in the Ayr plantation. This study resulted in a report covering aspects from genetic variability in neem trees and the possibilities for cloning, through to the efficacy of azadirachtin in relation to a range of insect pests (Simpson, 1995). This report remains the most authoritative publicly available investigation of the potential for neem that has been undertaken in Australia to date.

A neem tree plantation was established by Comalco at Weipa in North Queensland many years ago as part of a minesite rehabilitation program but with a long term aim of encouraging some form of income generation for the neighbouring Aboriginal communities. A privately owned neem tree plantation is situated in the Gilbert River region of North Queensland. Product from this plantation is currently marketed as described previously in Section 3.1.

Other neem tree experimental work has been conducted at Ayr in North Queensland by the QDPI and also in the Northern Territory. It is understood that the trees at Ayr have been removed.

4.2 Intensive Production

While neem trees will undoubtedly grow satisfactorily in the dry tropics of northern Australia, this of course will not be sufficient to develop a commercial Australian neem tree industry. A competitive production system in Australia would depend on a number of factors and would be most likely geared towards intensive production, with selection of high yielding clones, clonal propagation, high density planting, mechanical harvesting, and use of irrigation and fertilisers.

A mechanical harvesting system for the seed (e.g. shaking systems, net collection etc) would be critical. Seed is assembled in India and other countries by hand. Labour rates in Australia would make production uneconomic without mechanical harvesting. Efficient mechanical harvesting implies high yields of seed and /or azadirachtin and hence intensive production. Mechanical harvesting was critical in developing a coffee industry in Australia and will be critical in the current development of a cocoa industry; both crops are grown in developing countries with use of high labour inputs.

High concentrations of azadirachtin in the seed would be necessary for processing to be economically feasible. Hence, it is likely that selection of high yielding trees and propagation of such trees would be necessary in order to lower costs of production. Some information is already available regarding concentrations and genetic variability (Simpson, 1995) and it is understood that further selection work may have been undertaken by the private sector.

Tissue culture was used to produce the neem trees planted at Ayr. One problem manifest was that the trees were not as strong rooted as expected; this may have resulted from the propagation methods used.

Cultural practices of fertilising and irrigation may be necessary in order to obtain the growth rates and seed yields necessary to lower costs of production relative to those in India and other countries.

4.3 Processing

Extracting azadirachtin from the seeds would need to be effected through an efficient process to ensure that any ensuing extract could be priced at a level that would allow profitable market penetration. Processing of neem seed is a highly capital intensive operation and scale economies would demand a reasonably high level of seed throughput. The amount of solvent used per unit of extract is likely to be important cost-wise, so favouring operations involving seeds with high concentrations of azadirachtin.

Before considering the potential for growing neem trees in Australia, consideration should be given to the world market for seed or azadirachtin extract as this would determine prices faced by neem tree producers in Australia.

Neem seeds are currently available from a number of overseas countries including India, northern Cameroon, Nigeria, Gambia, Cuba, Barbados, Honduras and Antigua. Other literature suggests neem trees are also found elsewhere in the Middle East, northern Africa, and also Pakistan, Burma, Malaysia, Indonesia and southern China (Rungrojwanich 1990; Schmutterer, Ascher and Rembold 1986).

Desirable neem seed characteristics are product consistency, low moisture levels, low contaminant levels (leaves, twigs etc), and high azadirachtin content. Neem seeds should not be contaminated with aflatoxins as these substances are toxic to humans. In particular Aspergillus flavus is commonly found to exist on neem seeds which have been sitting on the ground underneath the neem tree for extended periods of time.

It is vital to source high quality neem seeds in order to produce a consistent and effective end product. Fresh seed is said to contain azadirachtin of higher value and less likely to contain aflatoxins than seed that has been stored; however, this statement probably requires further validation.

It is desirable for the azadirachtin content of the dried neem kernel to be at least 0.7%, or between 0.3% and 0.6% of the undried neem seed. Overall, high quality fresh seed is desirable and should be sought in order to increase the efficiency and profitability of the extraction operation. This may favour processing plants close to where the seed is grown but this may not be necessarily so if efficient handling and transport systems are available. Commercial quantities of neem seed could be obtained from India, or other areas such as Indonesia, the Philippines or Malaysia. It is understood that US manufacturers of neem based products source their seed and extract from India.

It is feasible to suggest there would be a long-term supply of neem seeds available for purchase from India and other locations. The potential threat of US chemical manufacturers expanding neem processing operations to an extent whereby neem seeds are unavailable to other markets appears unlikely at this stage. However, the quality of neem seed raw materials from overseas may be unreliable, especially if any processing operation in Australia grew to a significant size.

It would be characteristics of quality and price of seed that would determine whether seed produced in Australia could be competitive with overseas seed production.

An integrated industry operation (seed growing integrated with azadirachtin extraction) in Australia would be one possibility as to how an industry might develop in Australia. High and consistent quality

of seed grown in Australia would provide the extraction operation with a competitive advantage. How large this advantage would be, given the likelihood of the relatively high costs of production of seed in Australia, is a key question. Without a local market for end product, such an operation may be at a disadvantage.

4.4 The Viability of an Industry in Australia

The report referred to earlier (Simpson, 1995) assessed the feasibility of developing the neem industry in Australia. The QDPI found the economics of producing neem seed in Australia did not appear favorable in comparison to seed produced in India. They state "...growing neem is only likely to be profitable given exceptional prices, yields and harvesting efficiencies. These conditions don't exist nor are they likely to exist in the short to medium term."

Quality neem seed in commercial quantities could be produced from Australian plantations for processing in Australia in the future if the production economics were favourable and an extraction operation were to be established here. At present neither of these conditions appear likely. The lack of Australian registration of products currently works against any processing operation in Australia, either from seed produced in Australia or elsewhere.

If Australian neem seed producers were to supply export seed markets they would face competition from existing producers, as well as from other sizable plantings of neem trees taking place or planned in other countries including southern China, Florida and Haiti. More information on these plantings would be desirable but its assembly was beyond the scope of this brief review.

Although the economic analysis contained in the 1995 report appears sound, it was restricted to the economics of seed production. Further analyses incorporating extraction, manufacturing and marketing operations could be useful to assess the likely economic viability of a prospective operation under present conditions. Factors to take into account in an assessment of an integrated operation would include:

- Establishment costs
- Age to seed bearing
- Seed yields expected
- Cultural practices to be used
- Price expected for seed (in a horizontally organised industry)
- Availability and efficiency of extraction processes
- Costs of extraction
- The market and price for oil and cake residue
- Registration processes including efficacy considerations
- Product markets to be penetrated
- Formulations used including extract concentrations
- Prices that could be realised for different levels of market penetration

Assumptions could be made on some of these factors initially, but a high level of R&D investment may be necessary to reduce costs and ensure quality seed (e.g. the seed harvesting operation). Further R&D would be required in the extraction/seed processing operation. And of course registration of products is not simple nor costless.

Enhancement of the profitability of neem tree production for chemical extraction could be achieved through carbon sequestration incentives. Also, the wood from neem may be valuable but utilisation thereof would conflict with both neem seed production and carbon sequestration, and would have to be considered as a separate economic activity.

A form of extensive production (without irrigation and fertiliser) but utilising mechanical harvesting would be intuitively attractive provided growth rates and seed yields would be high enough to justify

the overall investment. As mentioned previously, the economics of harvesting could work against low yielding extensive plantings.

Efforts are currently being made on establishing neem trees in three provinces of southern China. It would be useful to investigate the Chinese expectations regarding planned provincial locations, production expectations, and marketing plans. It is also understood that plantings are planned in Florida, USA and in a rehabilitation program in Haiti.

5. Adaptation and Growth in Temperate Regions

The neem tree has a deep tap root and an extensive root system which enables the tree to exploit highly leached soils and withstand prolonged drought (Jenkins, 1989). In this regard it has been suggested that the tree may have potential to play a role in combating rising watertables and hence delaying or preventing the onset of dryland salinity, for example in the Western Australian wheatbelt.

The natural habitat of the neem tree is the dry tropics but it is known to grow in a range of other environments. It is often more common for a tropical tree well adapted to summer rainfall to adapt to cooler subtropical and even temperate conditions with some winter rainfall (Doran, J, pers comm, March 2000), than for a temperate tree to adapt to summer rainfall and hotter conditions.

However, cool weather is likely to slow the growth of the neem tree and young trees can be killed by frost. Neem trees are not well-suited to fine sands or silty soils. Neem is said to thrive best in tropical climates with hot dry winters and hot wet summers with an annual rainfall of 500 to 1500 millimetres (Jenkins, 1989).

Some information was gleaned from running the FAO ECOCROP1 file for neem through the PLANTGRO Model. In terms of brief cold, the tree would be tolerant down to about 10 degrees C (night temperature) and would be tolerant down to about 14 degrees C for extended cold (average minimum temperature). However, it is quite heat tolerant (up to 50 degrees C) and prefers overall hot conditions with an average of around 33 degrees C (Hackett, C., pers comm, March 2000).

Having indicated that the neem tree may grow in more temperate conditions, little information appears available to assess how the neem tree might adapt to West Australian wheat belt conditions. It is quite possible that growth rates, seed yields and the azadirachtin content of the seeds may be lower than in warmer, summer rainfall conditions. In this regard it would be useful to monitor overseas plantings, particularly those in southern China where winter temperatures are not high.

Much of the above is speculative, but in terms of broad acre dryland production, it is unlikely that seed could be produced and harvested economically in the West Australian wheat belt, unless selection for high azadirachtin content of the seed in that environment were successful. It is more likely, taking into account commercial considerations only, that plantations as far north in Australia as possible, and with irrigation available, would be more likely to produce seed in a competitive manner with other parts of the world.

6. Findings

- (i) There are currently no neem products registered for therapeutic or agricultural or veterinary use in Australia, despite a number of attempts in the past and the long history of the tree. Hence, there is no current market for azadirachtin extracts in Australia.
- (ii) The commercial world market for neem extracts and products is unknown but is thought to be relatively small.
- (iii) Extraction processes, residues from extractive processes and the breakdown of metabolites from azadirachtin are constraining registration of neem chemicals in Australia.
- (iv) There is a high and growing demand for natural and 'safe' insecticides. However, despite having shown to be effective in selected instances, there are some questions over the broad-scale efficacy of azadirachtin based products, compared to existing chemicals used.
- (v) Currently seed can be produced at lower cost overseas than that likely to be incurred in Australia largely due to harvesting methods and the cost of labour.
- (vi) For a competitive industry to be developed in Australia, it is likely that much effort would need to be invested in selection and clonal propagation, cultural practices, harvesting methods, and extraction processes.
- (vii) Neem trees may have to be produced under intensive conditions in Australia in order to obtain the seed and azadirachtin yields, and low mechanical harvesting costs, necessary to make an extraction and marketing venture financially attractive.
- (viii) There are a number of factors currently operating against commercial production in Australia. Some of these are being tackled by the private sector and significant enthusiasm still exists.
- (ix) While the neem tree is reasonably well adapted to different environments and may be useful in drawing down water tables, little information is available on how it might produce in terms of growth rates, seed production and azadirachtin content in cooler and wetter winters and drier summers than experienced in its natural habitat.
- (x) According to the outputs from the PLANTGRO model, the ideal average temperature for the neem tree is 33 degrees C. It will grow down to 10-14 degrees C. The tree will not tolerate much above 53 degrees.
- (xi) Overall, if the neem tree is to be commercialised in Australia, it is more likely to be grown in the more favourable conditions in northern Australia, rather than in more temperate conditions.

7. References

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8. Appendix

Appendix 1: Terms of Reference

Carry out a desk top study to:

- (i) Assess the potential for the use of neem tree production systems in low rainfall areas of Australia from the point of view of technical and economic viability as well as resource sustainability.
- (ii) Assess the current and future potential domestic and export markets for neem oil and neem products produced in Australia