



# The Introduction and Domestication of *Azadirachta indica* in Dry Hot Valleys of China

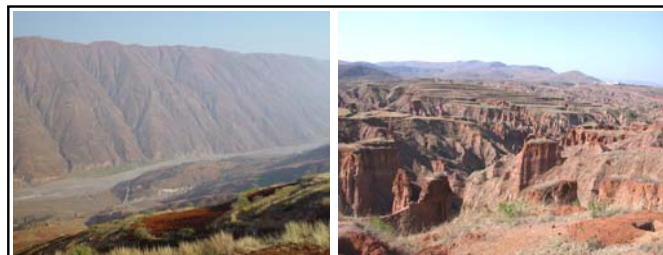
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## Introduction



Degraded lands in the dry hot valleys of SW China are difficult to restore.

Dry hot valleys refer to areas with tropical climate conditions, but with extremely dry winters and springs. These areas are mainly distributed along the Jingsha, Honghe, Nujiang, and Lancangjiang rivers in southwest China. Overcultivation and erosion have led to serious degradation in the dry hot valleys. Rainstorms are frequent and hard, and cause soil erosion in areas without vegetation. Many degraded lands have been abandoned. It is especially difficult to revegetate and restore these areas.

Furthermore, these dry hot valleys are the watersheds of Yangtze, Salween and Mekong Rivers and are essential habitats for people, plants and wildlife. Population is much higher than the average here because high temperatures are good for growing agriculture crops. Reforestation and restoration are becoming a serious challenge on degraded arid and semiarid lands. The cost of reforestation is high due to low survival rates and a high labor requirement for land preparation, planting, and management. Yunnan is a poor province, and local farmers are unwilling to plant native trees because they do not provide income even though they are good for ecological habitats and the environment.

Instead, farmers prefer to plant fast growing introduced species adapted to the harsh environment that provide a direct economic benefit. First introduced to China in 1995, neem (*Azadirachta indica* A. Juss) has become popular. An arbor species of *Meliaceae*, Neem originated from the subcontinent of southern Asia.

The government is seeking a solution to reforest arid areas, prevent soil erosion, and economically boost farmers' livelihoods. The Research Institute of Resource Insects of the Chinese Academic of Forestry began work on introducing neem in 1995. As a multipurpose tree, almost every part of the tree can be utilized, but the seeds are the most important, as they are an essential raw material for the growing biopesticide industry. This poster presents results from a ten-year project conducted to determine the feasibility of introducing neem as a solution to some of the erosion and subsistence problems of dry hot valleys.



The headstreams of the Yangtze, Mekong, and Salween flow through Yunnan Province in SW China.

### Household Uses

- Pest repellent
- Food preservative
- Fuel
- Soap

### Agricultural Uses

- Forage
- Grain storage
- Pesticide production
- Manure, mulching,
- Denitrification



### Medicinal Uses

- Anti-pathogen, anti-malarial
- Anti-diabetic, anti-cancer
- Immunomodulator, fights skin diseases, wound healing
- Anti-bacterial, anti-viral

### Forestry Uses

- Reforestation
- Improvement of soil
- Windbreak

Neem (*Azadirachta indica*) is a multipurpose tree.

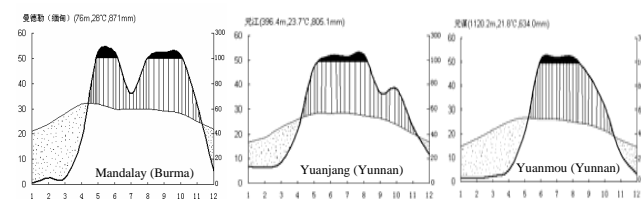
## Materials & Methods

To successfully introduce neem to dry hot valleys, research was conducted on neem's ecological adaptability, seed quality, cultivation, and propagation.

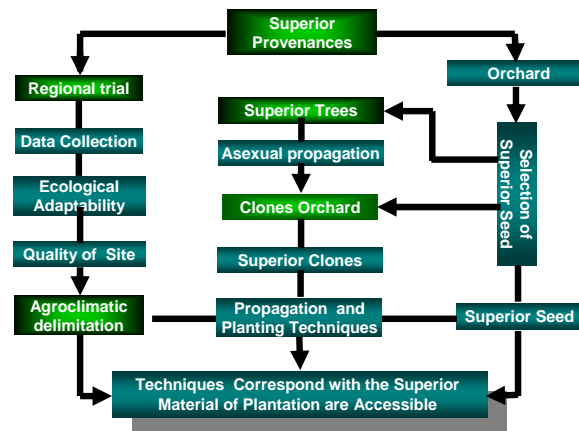
- The ecology climate diagram method was used to estimate climatic similarities between dry hot valleys and native habitats of neem to determine the best seed sources for introducing neem.
- 23 neem provenances were introduced from different regions in native habitats of India and Myanmar. Provenance and regional trials were conducted to determine the best provenances for different purposes and regions.
- An index system of criteria was created to estimate superior provenance and elite individual parent trees. Criteria included survival rate, resistance to dry soil, seed productivity, and the concentration of azadirachtin in the kernel.
- Superior individual maternal trees were selected among the superior provenances based upon characteristics of azadirachtin content, seed productivity, and adaptability to harsh conditions in dry hot valleys.
- A ten year scheme was created to guide research for the introducing neem for 1) revegetation purposes and 2) plantations for producing seeds used for production of biopesticides.
- Asexual propagation methods were used to produce clones for preserving the original introduced germplasm material.
- Standard techniques for planting and cultivating neem were defined based upon field trial experiences.



Provenance and regional trials for the introduction of neem began in 1997.

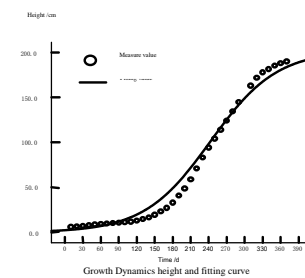


Ecological climate diagrams were used to compare native neem habitat with the hot dry valleys of Yunnan.



A ten year scheme was created to guide research for the introduction and domestication of neem in the dry hot valleys.

## Results



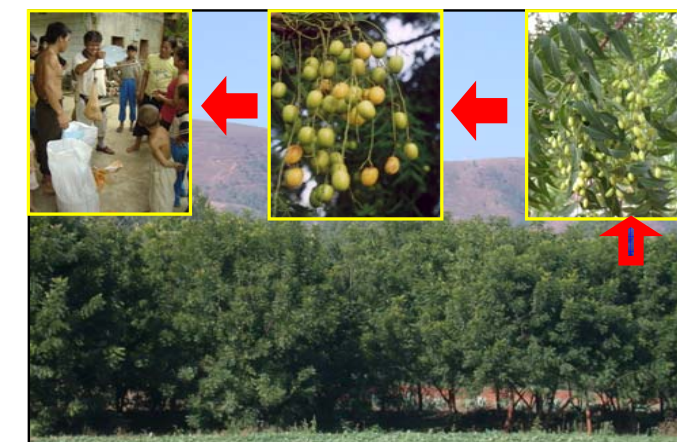
Neem seeds grow quickly and can be planted in the field within 9 months.

- 23 neem seed sources have been introduced from India, Myanmar, Thailand, Nepal, Togo, Senegal, and Malaysia since 1995. Most are from original native habitats.
- Provenance trial results recommended three seed sources for dry hot valleys for ornamental and reforestation purposes. These provenances are adapted to harsh land and climate conditions and grow faster without dieback in winter.
- Neem is proven to successful thrive in dry hot valley climates. It grows well where the minimum monthly mean temperature is higher than 12° C on altitudes up to 1200 m. Neem is sensitive to temperatures below 0° C. It can survive on harsh land with a dry climate but cannot withstand water-logged areas and clay soil. Neem trees need little water and plenty of sunlight. Thus, the growth of neem is restricted by temperature and soils to the dry hot valleys.
- The concentration of azadirachtin in the neem kernel varies from 0.32% - 0.68% in different provenances. Concentration varies from 0.21% - 1.10% among samples of individual trees.
- The concentration of azadirachtin was tested for correlation with the fruit ripening stages, seed dimension, kernel yield, and kernel weight. Azadirachtin content only correlated to seed dimension and reaches its peak with a dimension ratio of 2.29.
- From excellent maternal trees, 11 elite clones have been selected and reproduced by cutting, grafting, and tissue culture. Elite clones yield three times the average seed yield with a concentration of azadirachtin of at least 0.8%.
- Two orchards (23hm<sup>2</sup>) have been established in Yuanmou and Yuanyang, and include a resource garden and scion plucking nursery for preservation of original germplasm and elite clones for vegetative propagation.
- Based upon regional trials and a study of ecological adaptability, an agro-climatic delimitation established normal regions and primary planting areas for dry hot valleys.
- 7,000 instructional booklets were distributed to local farmers on how to grow neem. These publications include basic information on neem and demonstrate planting and growing techniques.
- 20 million seedlings have been planted by local farmers in dry hot valleys since 2000. More than 95% of the seedlings were developed from seeds introduced from Myanmar. Prior to 2002, seeds were imported from Myanmar, but since 2003 seedling production in Yunnan has exceeded demand.

Top left to right: Neem can be cultivated by grafting, tissue culture, and cuttings. Bottom left to right: Neem has been planted successfully in provenance trials, plantations, and "ecological forests" for soil restoration.



A dramatic change is seen within two years of planting neem.



Farmers are able to sell neem seeds to buyers from the growing biopesticide industry, which is based in Kunming.

## Discussion And Conclusions

- Work must be done to reduce the cost of biopesticides made from neem seeds. It is theoretically and technically feasible to improve the yield and the concentration of azadirachtin of seeds by growing plantations of selected elite clones.
- It is certain that the concentration of azadirachtin in the kernel is inherited, however, concentration varies drastically among offspring from identical maternal trees. Crossbreeding must be used to improve azadirachtin concentration.
- Further research is needed on the index system of criteria for estimating provenances and elite clones, particularly as more is learned about neem.
- Tests on the stability of azadirachtin contents from clones and single parent filial generations are additional priorities for further research.
- A study of environmental factors impacting azadirachtin concentration was launched in 2005. This research project included a series of trials to determine how and to what degree temperature, moisture, light, and soil nutrition impact azadirachtin concentration in the kernel.
- The introduction of neem may have some risks for native species and environments, but to what degree is uncertain. Neem should be cautiously planted in riparian areas because some aquatic species are sensitive to azadirachtin.



Neem holds great promise for restoring degraded land in the hot dry valleys, as well as for providing income to local farmers.