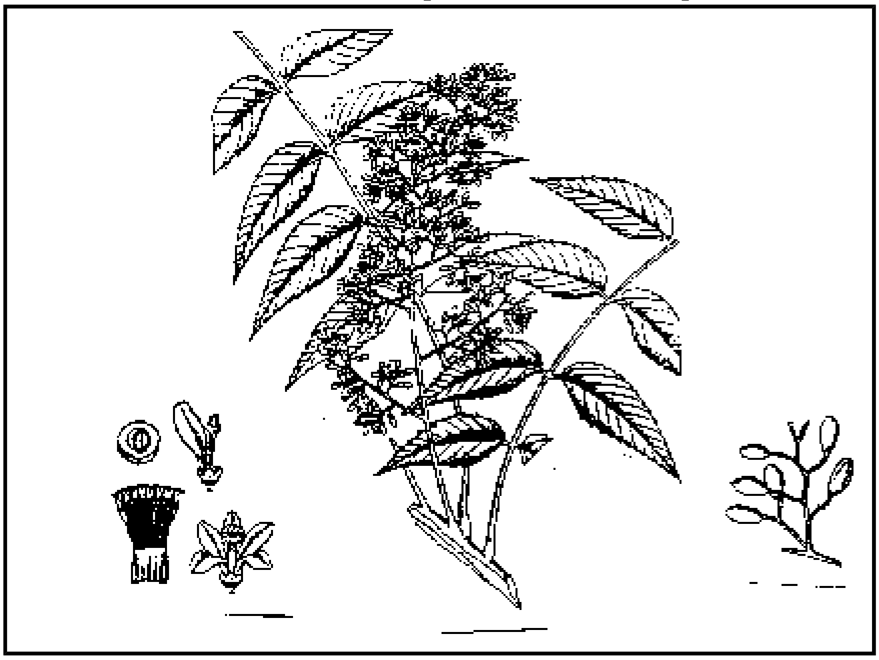
FACT Sheet

FACT 98-01, January 1998

A quick guide to multipurpose trees from around the world

Use of neem as a Biological Pest Control agent

The neem tree (*Azadirachta indica*) has been introduced and established throughout the tropics and sub-tropics for its highly valued hardiness, its almost year-round shade, and its multiple wood and non-wood products. Agroforesters have promoted it for use in windbreaks, fuelwood plantations, and silvo-pastoral systems, especially for dry zones and infertile, rocky, sandy or shallow soils. People have long recognized that the leaves, bark, wood and fruit of the neem tree either repel or otherwise discourage insect pests, and they incorporated these plant parts into traditional soil preparation, grain storage, and animal husbandry practices. Through more recent chemical analysis the active compounds in neem tissues have been identified. Several neem-based biological pest control (BPC) products have been developed and approved for commercial distribution in some countries. The neem tree can provide an inexpensive integrated pest management (IPM) resource for farmers, the raw material for small rural enterprises, or the development of neem-based industries.



Neem's active ingredients and their impact on pests

Azadirachtin has been identified as neem's principal active compound. It acts on insects by repelling them, by inhibiting feeding, and by disrupting their growth, metamorphosis and reproduction. Neem-based formulations do not usually kill insects directly, but they can alter their behavior in significant ways to reduce pest damage to crops, and reduce their reproductive potential. Azadirachtin affects insect physiology by mimicking a natural hormone. It has been shown to affect egg production and hatching rates. In larvae, azadirachtin can inhibit molting, preventing them from developing into pupae.

Many foliage feeding species will avoid plants treated with neem compounds or will cease eating after ingesting them (NRC, 1992). Its has proven effective as an antifeedant on about 100 insect species (Read & French, 1993). Thus, the extracts work especially well to protect plants from defoliation without affecting beneficial pollinating insects like honeybees.

Overall tests of neem extracts have shown results on about 300 insect species, mostly in the Orthoptera (grasshoppers, katydids, etc.); Homoptera (aphids, leafhoppers, etc.); Dictyoptera (cockroaches and mantids); Lepidoptera (moths and butterflies); Heteroptera (true bugs); Diptera (flies); Coleoptera (beetles and weevils); Hymenoptera (bees, wasps and ants); Isoptera (termites); Thysanoptera (thrips), and Siphonaptera (flea) orders (NRC, 1992; Randhawa and Parmar, 1993).

Even crudely produced neem extracts can provide excellent control of caterpillars and beetle larvae, and are effective on grasshoppers, leaf miners, and leaf and plant-hoppers. Commercially produced neem preparations can suppress a broad range of pests including insects, centipedes, millipedes, mites, and nematodes.

Traditional uses of neem

Farmers have traditionally used various components of the neem tree such as oil extracted from the seed, neem cake, (the residue left after pressing the oil) and the leaves as well as the wood. Farmers in India use neem cake as an organic manure and soil amendment. It is believed to enhance the efficiency of nitrogen fertilizers by reducing the rate of nitrification and to inhibit soil pests including nematodes, fungi, and insects (Gupta, 1993). Neem leaves and small twigs are also used as mulch and green manure.

Neem leaves and neem oil have also been used traditionally to protect stored grains and legumes. Neem leaves are mixed with the grain in storage or the grain is stored in jute bags treated with neem oil or other neem extracts. These methods can protect food and seed stores from insect pests for several months.

Another traditional agricultural practice involves the production of "neem tea." The seeds are dried, crushed and soaked in water overnight to produce a liquid pesticide that can be applied directly to crops. Crushed seed kernels are also sometimes used as a dry pesticide application, especially to control stem borers on young plants. These home-made remedies are often very effective at repelling pests or acting on insects as a feeding deterrent, even if they do not actually kill them. The strength of home-made preparations can vary due to the concentration of azadirachtin and other compounds in the seed, which can in turn depend on the genetic source of the seeds. It can also be affected by the process of handling and drying the seeds, contaminants in the water, and exposure to high temperatures or sunlight. The active compounds break down quickly, so an application of neem tea can generally provide protection for only about one week.

Neem is a species of the Mahogany family, and although it has some of the characteristics of a cabinetry wood, its grain is rough and does not polish well. Neem wood is, nevertheless, used to make wardrobes, book cases and closets, as well as packing cases because the wood helps to protect the contents from insect damage (Read & French, 1993). The main stem of the tree is also widely used to make posts for construction or fencing, because the wood is termite resistant.

Farm-level production and use of neem extracts

Farmers with ready access to seed producing neem trees can prepare their own "neem tea" using simple procedures to extract the active compounds. Ripe seeds should be collected from the trees, and the seeds should be depulped, washed clean and dried as soon as possible after harvesting. Seeds should be dried in the shade for 3-7 days. Seeds should be checked, and any that have been contaminated by mold or fungus should be rejected. The dried seeds are then finely crushed in a mortar or mill. About 500g crushed seeds should be mixed with 10 liters water and the mixture should be left to sit overnight. The next day the mixture should be filtered through fine cloth or gauze. It is then ready to be applied directly to crops using a spraying, brush or swab technique. The mixture should not be applied more than once a week, and treatments every 10-15 days is usually adequate for control of normal pest problems. Unused extract should be carefully stored in a closed container in a cool dark protected area (GTZ, n.d.).

Neem extracts can be made from leaves and other tissues, but the seeds contain the highest concentrations of azadirachtin. Industrial scale extraction processes use solvents such as alcohol, ether, and hydrocarbons instead of water. Some sources claim that the waterbased extracts work nearly as well, although using the method described above it is difficult to determine the concentration and therefore the appropriate amount to be applied. In Pakistan a process of freeze drying the water-based neem extract produces a crystalline powder called "neem bitters" that is water soluble (Read & French, 1993).

Small-scale processing for use in rural enterprises

Although efforts have been undertaken by NGOs to promote neem-based micro-enterprises in rural areas to increase employment opportunities, few have succeeded. Challenges they have faced include difficulty in producing uniform concentrations; problems with packaging, storage, and transportation; and lack of information about potential markets. These are common constraints to the development of small agro-enterprises and probably can be overcome. Neem-based enterprises have special potential where it is possible to reach producers who have a market for organic produce and in areas where commercially distributed pesticides are unavailable or too expensive for the average farmer to afford.

Commercial uses of neem

Neem oil has long been produced in Asia on an industrial scale in soaps, cosmetics, and pharmaceuticals. During the 1980s companies began commercial production and distribution of pest control formulations that use azadirachtin as the principal active ingredient. Interest in BPC agents has developed along with the environmental and consumer rights movements, and the recognition that IPM strategies are needed to sustain agricultural production. New markets for organically grown produce and "natural" products also spurred the development of the BPC industry, and azadirachtin was among the first to be commercialized.

In the United States neem-based BPCs were first approved for use on non-food crops in 1985. After subsequent testing, the Environmental Protection Agency (EPA) regulated the use of Dihydroazadirachtin (DAZA), a reduced derivative of azadirachtin, for use on food crops. In 1996 the EPA exempted raw agricultural commodities from meeting DAZA residue requirements, as long as the chemical is applied as an insect growth regulator or antifeedant at no more than 20gms/acre with a maximum of seven applications per growing season (EPA, 1997). The EPA only allows this exemption if approved commercial products are used; food products treated with home-made extracts would not meet these requirements.

Environmental issues

Neem compounds do not persist or accumulate in the environment after being applied as pesticides. They break down quickly when exposed to sunlight, usually within one week. Commercial preparations contain sunscreens which maintain their effectiveness for 2-3 weeks. Neem extracts may have toxic effects on fish, other aquatic wildlife, and some beneficial insects. Therefore, care should be taken in disposing of any unused extracts, by exposing them to heat or sunlight to break down the active compounds.

Neem fruits are an important source of food for some wildlife, especially birds and bats, although they only digest the pulp, not the seed. Neem compounds have been judged to be relatively non-toxic to mammals. Azadirachtin is so effective against insects, because it imitates a naturally occurring hormone that disrupts insect life cycles, however, this hormone does not occur in vertebrates. The United States EPA has concluded that if approved procedures for its application are followed that, "no unreasonable adverse effects to human health are expected from the use of DAZA" and "there is a reasonable certainty of no harm from dietary exposure" (EPA, 1997). Neem oil has been used traditionally as a topical treatment for skin symptoms in both humans and livestock, but it should not be injested orally.

Issues for research
Researchers believe that even modest efforts at genetic improvement could result in higher seed yields, higher levels of azadirachtin, and other useful compounds in the seed. Management of neem plantations for BPC production will require research to determine appropriate silvicultural practices, such as tree spacing, pruning or lopping to promote seed production, as well as possibilities for intercropping within the plantations. More research is also needed on the other bioactive compounds found in neem and on how they interact to repel or deter insect predators. Some of these also have shown anti-fungal and anti-viral properties. Farmers need better methods for preparing neem extracts to ensure uniform concentrations and quality. They also need better information about how to apply the extracts to maximum effect on different insect species at different life cycle stages. Long-term environmental impacts of the use of neem-based BPCs should be monitored and assessed.

Selected References
An introduction to neem botany, ecology, distribution, uses, silviculture, and management is provided in FACT-Net's FACT Sheet 97-05: *Azadirachta indica: neem, a versatile tree for the tropics and subtropics* (September, 1997). Key references for this FACT Sheet include:

Bunders, Joske; Bertus Haverkort, and Wim Hiemstra (eds.), 1996. *Biotechnology: Building on Farmers' Knowledge.* London: MacMillan Education Ltd.

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), not dated. *Neem a Natural Insecticide*. 34 pp.

Gupta, R.K., 1993. *Multipurpose Trees for Agroforestry and Wasteland Utilization*. International Science Publisher, New York, NY.

National Research Council (NRC), 1992. *Neem: A Tree For Solving Global Problems*. National Academy Press, Washington, D.C.

Randhawa, N.S. and B.S. Parmar (eds.), 1993. *Neem Research and Development*. New Delhi: Society of Pesticide Science, India.

Read, Michael D. and James H. French, eds. 1993. *Genetic Improvement of Neem: Strategies for the Future*. Proceedings of the International Consultation on Neem Improvement held at Kasetsart University, Bangkok, Thailand, 18-22 January, 1993. Bangkok, Thailand: Winrock International. 194 + x pp.

United States Environmental Protection Agency (EPA), 1997. Pesticide Fact Sheet.

Written by Carol Stoney, Program Officer and Erin Hughes, Program Associate
Winrock International

A publication of the Forest, Farm, and Community Tree Network (FACT Net)

Winrock International
38 Winrock Drive
Morrilton, Arkansas 72110-9370, USA

Phone: 501-727-5435
Fax: 501-727-5417
Email: forestry@msmail.winrock.org

www.winrock.org/forestry/factnet.htm