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NEEM FACTSHEET
FOR USAID MISSION AND IMPLEMENTING PARTNERS

PURPOSE OF FACTSHEET: Provide Missions and Implementing Partners (IPs) information to assist in the safe production, use, and disposal of neem as well as explore the difference between homemade or artisanal neem and commercially produced neem pesticide products. The factsheet can be used to help IPs in development of their Environmental Mitigation and Management Plan when they are including neem in their activities.

Use of neem commercial products supported with USAID funding must be approved by an applicable USAID PERSUAP. Commercial product must always be used in accordance with the pesticide label.

DEFINITION OF NEEM: The neem tree is a broadleaved, seed-propagated perennial woody tree of Genus: Azadirachta and Family: Meliaceae (the Mahagony family). Its scientific name is Azadirachta indica and it has two closely related species, Azadirachta indica A. Juss and Melia azadirachta.

The Neem tree is a fast-growing evergreen that can be identified by a straight trunk with rough and scaly bark that is brown in younger trees; as it matures the tree can be paler brown or greyish-black with simple pinnate leaves, smooth olive-like fruit, and white fragrant flowers. The average height is 15-20 meters, but it can reach 40 meters with spreading branches that form rounded crowns up to 20 meters across. The neem tree can tolerate high temperatures as well as poor or degraded soil, but in severe drought it can drop most or all of its leaves. (See photo above)

The exact origin of the neem tree is unknown, but it is thought to be native to the Indian Subcontinent (India and Bangladesh) and Southeast Asia.[1] The neem tree is widespread throughout arid, tropical, and subtropical areas of the world. It was introduced to Africa in the early 20th century and is now well-established on the continent.

Common neem names include: Arishta, Arishtha, Bead Tree, Holy Tree, Huile de Neem, Indian Lilac, Indian Neem, Lilas des Indes, Lilas de Perse, Margosa, Margosa Tree, Margousier, Margousier à Feuilles de Frêne, Margousier d'Inde, Nim, Nimb, Nimba, Persian Lilac, Pride of China, Mkilifi, Mwarubaini kamili (in Kiswahili).

[1] https://www.ncbi.nlm.nih.gov/books/NBK234651/

NEEM AS A PESTICIDE: The neem tree is known for its various benefits and uses, including as a pesticide. Its oil contains over a hundred biologically active compounds, some of which are triterpenes known as limonoids. The most prominent among them is Azadirachtin, which is typically the chemical providing most of the pesticide action. Other constituents found in neem that exhibit pesticidal qualities are Melantriol and Salanin. Some research shows that Nimbin and Nimbidin found in neem seeds might have anti-bacterial and anti-viral activity.

While all parts of the tree - including leaves and fruit - contain some level of Azadirachtin, the neem seed contains the highest levels. Triglyceride oil from the seeds (comprising about 30–50% of the mass) will contain azadirachtin (~0.2–0.8% by weight of neem seed kernels).

The effectiveness of neem as a pesticide depends on the concentration of the active ingredient, the formulation, the pest type and the crop. The concentration may be very hard to determine and reproduce with homemade neem products and sometimes commercial products.

Neem artisanal pesticide products include: the natural neem oil obtained from seed, neem cake remaining from extraction of neem oil, direct application of shredded neem leaves, and neem aqueous or chemical (e.g., alcoholic) extracts prepared by steeping neem (e.g., ground neem seed, leaves, twigs and bark). Commercial neem products may contain natural neem oil, the active ingredient Azadiracthin that is extracted from neem oil, and the clarified hydrophobic neem oil remaining after extraction of Azadirachtin. Neem cake formulated as powder or granules or integrated into fertilizer is also packaged and sold as commercial products. Some farmers have noted that neem is an effective insecticide, nematicide, miticide or fungicide against up to 200 pest species (e.g., plant-eating insects, larvae) in various crops.

NEEM PESTICIDE MODE OF ACTION. Artisanal neem (containing azadirachtin, melantriol, salanin, nimbin, and nimbidin) and commercial neem products act on different insects through various modes, including: antifeedancy, growth regulation, fecundity suppression and sterilization, oviposition (egg-laying) repellency or attractancy, changes in biological fitness, and blocking development of vector-borne pathogens. Antifeedant activity is often short lived and variable. Neem oil is an insect growth regulator and is most effective against actively growing immature insects. Blocking the larva from molting is considered neem's most important pest control quality. Neem can work as a stomach poison on some insects, but they must ingest the active ingredient during feeding to be negatively affected. As such, its activity is better on chewing versus sucking insects; for instance, neem is effective against caterpillars. Repellency is considered the weakest mode of action for neem, but neem may repel some locust and grasshopper species.

Neem trees can withstand the periodic infestations of locusts. The antifeedant effect of neem on grasshoppers, crickets and locusts has been noted by researchers -- some species refuse to feed on neem-treated plants for several days or weeks. Some users note that neem turns the desert locust from a gregarious swarming form into a solitary form, and that it reduces the ability of adult locusts to fly.

PESTS CONTROLLED WITH NEEM. Neem products are medium- to broad- spectrum pesticides of plant-eating (phytophagous) insects. They affect members of most orders of insects – in particular, aphids, leafhoppers, psyllids, whiteflies, scale insects, and other homopterous pests are sensitive to neem products (to varying degrees). Larvae of many pests are highly sensitive to neem as it blocks them from

feeding and disrupts their growth. Neem has shown to be effective on thrips larvae found in the soil. Neem has also been shown to be an effective prophylactic against armyworms.

Neem products affect pests of public health and veterinary importance such as mosquitoes, flies, triatomines, cockroaches, flies, and lice; however, current application of neem products for the control of disease vectors and human and animal pests is limited.

Another finding is that fields top-dressed with neem cake are less affected by nematodes, snails, and certain fungi. Neem oil sprays have some fungicidal activity and are used for control and treating plant diseases such as rust and powdery mildew (although similar effects have been produced with other horticultural oils). Farmers sometimes mix neem leaves with grain to protect grain against storage pests. Precautions should be taken to ensure that neem residues are not present in grain or seeds intended for human and/or animal consumption.

CROPS FOR WHICH NEEM CAN BE USED. Neem-based pesticide products can be used on a wide range of crops, including garden and cash crops, herbs, fruit tree crops and ornamental crops. USEPA does not establish upper legal level for residue concentration for cold pressed neem oil in food commodities. Therefore, the maximum amount of neem oil residue that is expected to be ingested when using cold pressed neem oil - as directed by the product label – is not expected to be of concern to human health.

Phytotoxicity (damage to plants) may be of concern for certain formulations of neem-based products. Some evidence suggest that application of neem may inhibit germination and growth of several specific crops: alfalfa, bean, carrot, radish, rice, and sesame and some weeds. Regardless of the type of plant being treated, neem oil can damage plants by burning their foliage and therefore should not be used on recent transplants or otherwise stressed plants. Trial applications of artisanal products should be made before applying to larger areas and product label should always be checked to avoid injuring plants.

EXAMPLES OF CROPS FOR WHICH USAID HAS PREVIOUSLY APPROVED THE USE OF COMMERCIAL NEEM PESTICIDE PRODUCTS INCLUDE:

- Grains (e.g., rice, maize);
- Pod Seed pulses and legumes (e.g., soybean, cowpea);
- Roots/Tubers (e.g., cassava, sweet potato, yam, potato);
- Solanaceous crops (e.g., tomatoes, peppers, eggplants);
- Okra;
- Cucurbits (e.g., melons, cucumbers, squashes);
- Brassicas (e.g., cabbage);
- Fiber and oil crops (e.g., cotton);
- Seed and oil crops (e.g., sesame),
- Tree Fruit crops (e.g., banana), and
- Tea and coffee.

COMMERCIAL AND ARTISANAL NEEM PRODUCTS:

Both industrial commercial pesticide products and artisanal homemade products can contain neem.

COMMERCIAL NEEM PESTICIDES. Pest control products containing Neem Oil, Azadirachtin, and the Clarified Hydrophobic Extract of Neem Oil left over from extraction of Azadirachtin are registered for use by the US Environmental Protection Agency (USEPA).

Neem oil extraction occurs via four technologies: Mechanical Pressing; Steam Pressure Extraction; Solvent Extraction that uses solvents such as alcohol, ether, and hydrocarbons; and Super Critical

Extraction that uses "critical factors" carbon dioxide (CO_2) at high pressure (over 1071 psi/72.9 atm) and temperatures above 88°F (31°C) at levels that are "super to critical."

Neem products formulated as granules, dust, wettable powders, or emulsifiable concentrates are available in stores in the US and globally for use by the general public. Neem cake — obtained in the process of cold pressing neem tree fruits and kernels and the solvent extraction process — is packaged and available for sale as a fertilizer.

40 CFR Reg 216 procedural note: If a user has a store purchased neem product, they must have a valid PERSUAP and receive approval from the USAID A/COR as a restricted commodity. In all cases, neem production, use, and disposal (of product and byproducts such as seed cake) must be included as part of the IPs Environmental Monitoring and Mitigation Plan (EMMP).

ARTISANAL NEEM PESTICIDES. Neem pesticides are made by farmers from leaves, twigs, fruit, and seeds of the tree. Neem oil is obtained mostly from seeds, but can also come from fruit and leaves through mechanical pressure and chemical extraction. Neem cake is prepared from the de-oiled residue after pressing. The seed kernels of the neem tree contain the highest concentrations of neem oil with the active ingredient Azadiracthin, but the oil is not easily extracted.

PRODUCTION AND USE

MECHANICAL METHOD: To obtain neem oil, the seeds must be collected, cleaned to remove the skin, dried in the sun, and separated from foreign matter. Once dried, the seeds are pounded to separate them from the hard shell; the cleaned kernels are then crushed using mortar and pestle to obtain a fine mesh that is winnowed and sieved. The powder is moistened or steamed over boiling water, forming dough from which oil is extracted using a press. Since neem oil does not readily mix with water, an emulsifier such as soap can be used for mixing neem oil with water.

EXTRACTION METHOD. Neem leaves and twigs are used to prepare a pesticide using a variety of recipes. The artisanal extraction process usually occurs by steeping leaves and sticks in water and filtering the extract. Other solvents besides water can also be used, and sometimes – depending on local recipes – the filtrate is mixed with additional ingredients.

USE. The use of neem relies on a body of traditional and cultural knowledge, so application methods and uses may differ from region to region. For instance, neem oil products may be used as a spray or as a soil drench. Neem cake can be an effective fertilizer by mixing it with soil on and around the roots of plants, vegetables, bushes, and trees. However, any commercially purchased products must be used in accordance with their label regardless of local practices.

NEEM LEAF EXTRACT RECIPE

For 5 liters of water, 1 kg of green neem leaf is required. Since the quantity of leaves required for preparation of this extract is quite high (nearly 80 kg are required for 1 hectare), the extract can be used for smaller nursery and kitchen gardens. First, the leaves are soaked overnight in water. The next day the leaves are ground, and the extract is filtered. The extract is beneficial against leaf eating caterpillars, grubs, locusts, and grasshoppers. Emulsifier should be added to the extract.

HEALTH AND ENVIRONMENTAL HAZARDS OF NEEM PESTICIDE PRODUCTION AND USE

HAZARDS ASSOCIATED WITH NEEM-BASED PESTICIDE PRODUCTION

INJURIES FROM MECHANICAL EXTRACTION. The physical hazards associated with production of neem oil will depend on the methods of production. Artisanal preparation process is generally safe, but care must be taken to prevent body injuries during the process (e.g., use PPE).

USE OF HAZARDOUS CHEMICALS FOR CHEMICAL EXTRACTION. Neem homemade pesticide recipes sometimes call for the use of kerosene, naphthalene or other chemicals to facilitate active ingredient extraction or strengthen pesticidal action. Storage, pesticide preparation, and excessive use of such chemicals may pose health, environmental and physical hazards. In addition, use of kerosene presents additional flammability hazards.

LACK OF UNIFORM QUALITY. The quality of neem pesticide will vary depending on several factors, including health of the seeds, how the oil is extracted, and how the pesticide is prepared and used. Neem oil products are prepared from various trees of very different regions and climates, and therefore, their quality is not homogenous. For example, commercial neem oil producers can guarantee a concentration of the oil, but they cannot guarantee a constant level of Azadirachtin in the oil.

NATURAL NEEM OIL PESTICIDE PREPARATION

Note: Recipes for neem preparation may vary based on country and region. Always use appropriate PPE to avoid contact with eyes, skin and clothes when preparing or using neem pesticides. Wear goggles for eye protection, gloves for hand protection, an apron or coveralls to protect skin and clothes and wear gumboots when handling neem and neem products.

A) Gathering

1. Gather the fruits and pulp them to remove the flesh
2. Dry the kernels in the sun
3. Remove all foreign materials such as sticks and stones

B) Oil pressing

1. Crush the kernels in a mortar (because of the bitter taste and possible food contamination, use a separate mortar)
2. Remove the shells of the kernels by winnowing, as done with cereals
3. Grind the kernels in a mortar until a powder is obtained
4. Moisten the powder with a little water and form a ball (or steam it by placing it over boiling water for about 15 – 20 minutes to form the ball)
5. Knead the ball until oil collects on the surface
6. Press the oil out
7. 10 Repeat steps 8 and 9 until obtaining about a third to half a small bottle of oil per kg of crushed kernels

C) Neem oil spray

1. 5-30 ml Neem oil is added to 1 liter of water and stirred well. Emulsifier is added (1ml/1litre). It is essential to add an emulsifier and to mix properly. The mixture should be used immediately before the oil droplets start floating using a knapsack sprayer. Liquid soap or potassium silicilate are most commonly used emulsifiers.

LACK OF LABELS AND ABSENCE OF CORRECT AND SAFE USE INSTRUCTIONS. Artisanal/home made products are often kept at residences and are not properly labeled. Because neem oil is also used in cosmetics and for medicinal uses, unlabeled neem oil can be used in a manner that is harmful to people and the environment.

Pesticidal products that are placed in containers without a label, bearing a food or drink label, or otherwise improperly labeled can lead to poisoning or accidents. Similarly, pesticides in containers with insufficient safety data sheets do not provide instructions on how to use the product nor provide full disclosure or precautionary statements – i.e., which crops should be avoided, and what are the Pre-Harvest Intervals (PHIs) or Restricted Entry Intervals (REI) after spraying.

OVERUSE OF NATURAL RESOURCES. Although Neem is a hardy, fast growing tree that grows well under unfavorable climatic and soil conditions; is resistant to most pests and easily propagated from seed; and is considered invasive in parts of Kenya, Tanzania and Uganda (A.B.R. Witt pers. obs.), the demand for neem and neem seed has been growing quickly – scarcity of neem has been noted in some locations in India.

HAZARDS ASSOCIATED WITH NEEM-BASED PESTICIDE USE

HUMAN HEALTH HAZARDS. Neem products have low toxicity to humans and mammals. However, exposure to neem oil and Azadirachtin can cause skin, eye, and gastrointestinal irritation; stimulation and depression of the central nervous system has also been reported. Ingestion of neem oil can cause poisoning, but treatment primarily addresses symptoms, and recovery is usually complete. Use of safety goggles, chemical resistant gloves/coveralls and gumboots are essential when using neem products.

ENVIRONMENTAL HAZARDS. Pollinator insects, such as bees, are not likely to be harmed by neem oil as they are not likely to ingest it, but it can harm some useful insects. Neem is nontoxic to birds, mammals, and other plants, but it is moderately toxic to fish and other aquatic animals. Neem is biologically degradable and Azadirachtin is rapidly broken down in soil and water, and on plants. Neem does not appear to persist long after it is applied and has not shown to bioaccumulate; it does not bind well to soil and can easily move off the application area with rain or irrigation water. Neem products should not be directly applied to water bodies – or where drift or runoff can reach the water bodies -- or where honeybees are foraging.

LIMITATIONS OF USE

LACK OF EMPIRICAL DATA. Much of the information about neem effectiveness is based on exploratory investigations and empirical and anecdotal evidence. In some cases, there is a lack of laboratory data to substantiate the claims of neem effectiveness.

SLOW-ACTING. Even when applied correctly, neem can take time to work, and reapplication is usually necessary to completely control insect populations. The need for reapplication will depend on the type of the product used and may need to be reapplied within 7 to 21 days. The lack of rapid knock-down effect can reduce neem's attractiveness to farmers.

SUSCEPTIBILITY TO ELEMENTS. Repeat applications of neem are usually required. Neem products have short residual activity due to the oil susceptibility to ultraviolet light (sunlight) degradation. Neem oil is thermosensitive, meaning that above 50 °C its composition degrades.

Being produced in hot countries, neem's pesticidal property is affected by the source and conditions of its production, storage, and transport. In greenhouse and field trials, some neem materials have been found to damage plants.

MEANS FOR ENSURING SAFE PRODUCTION AND USE

TABLE 1: HAZARDS AND PRECAUTIONS FOR PREPARATION, USE, STORAGE AND DISPOSAL OF PRODUCTS

HAZARDS	PRECAUTIONS
Use of hazardous chemicals	Do not promote or support use of hazardous chemicals (e.g., kerosene) for preparation of neem products.
Preparation and handling may lead to physical injuries or poisoning.	Implement situation appropriate safety measures including use of PPE. Avoid contact with eyes, skin or clothing. Use goggles to protect eyes, gloves when handling neem, coveralls or an apron to protect skin and clothes and wear gumboots for feet protection when preparing or applying neem. Do not use the same equipment as what is used in food preparation.
Placing in mislabeled or unlabeled container may lead to poisoning, injury, or damage.	Place a label or mark homemade product noting the content, intended use, date when made, and place a warning sign on the container.
While not necessarily a hazard or limitation, preparation and use of neem products using traditional methods could result in unanticipated exposures.	Where appropriate, provide formal training in safer production and use of neem products.
Use or disposal may damage target or nearby plants	Test the neem product on a limited area before applying it to a broad area.
A re-entry interval of 4 hours is necessary for safety purposes.	Clearly communicate the appropriate re-entry interval and reasons for the waiting period. No preharvest interval is necessary.
Potential for environment contamination of soils, water, non-target species	Do not apply directly to or near water bodies. Neem breaks down fairly quickly when released into the environment. Microbes and light break down neem in soil, water and on plants. However, because of its toxicity to aquatic organisms, washing of neem containers or disposing of neem directly into the surface water should be avoided.

TABLE 2: RECOMMENDATIONS FOR EFFECTIVE USE OF ARTISANAL/HOMEMADE NEEM PRODUCTS	
ISSUES	RECOMMENDATIONS
Neem has a short shelf-life	In general, well-sealed containers of neem oil can keep up to one year but the shelf life will depend on the type of container and the storage conditions. (See additional considerations below)
The active ingredients in neem unstable over 38°C.	Do not overheat or boil the mixture. Do not store neem products in hot locations.
The active ingredients in neem are destroyed by acidic or alkaline pH emulsifier.	Use only neutral pH emulsifiers. Follow instructions on the label.
The active ingredients in neem are destroyed by direct ultraviolet rays of sunlight.	Spray during moderate sunlight, early in the morning or late in the day. Repeat applications are usually required. Do not store in direct sunlight.
The active ingredients in neem are destroyed by water hydrolysis.	Use aqueous mixture on the same day it was prepared. Do not store aqueous solutions of neem overnight.
Reliance of pesticides as first option for addressing pests may undermine acceptance of integrated pest management practices	When recommending neem use, consider costs and benefits of its use.
Solids are left after removal of neem oil	The solid residue left after the oil is removed from neem is employed as a fertilizer and soil amendment.

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