Family: ***Meliaceae***

Taxon: ***Azadirachta indica***

Synonym: *Antelaea azadirachta (L.) Adelb.*
Melia azadirachta L.

Common Name: Neem
Indian lilac

Questionaire : current 20090513 **Assessor:** Chuck Chimera **Designation:** H(HPWRA)
Status: Assessor Approved **Data Entry Person:** Assessor **WRA Score 9**

101	**Is the species highly domesticated?**	**y=-3, n=0**	**n**
102	**Has the species become naturalized where grown?**	**y=1, n=-1**	
103	**Does the species have weedy races?**	**y=1, n=-1**	
201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**(0-low; 1-intermediate; 2-high) (See Appendix 2)**	**High**
202	**Quality of climate match data**	**(0-low; 1-intermediate; 2-high) (See Appendix 2)**	**High**
203	**Broad climate suitability (environmental versatility)**	**y=1, n=0**	**y**
204	**Native or naturalized in regions with tropical or subtropical climates**	**y=1, n=0**	**y**
205	**Does the species have a history of repeated introductions outside its natural range?**	**y=-2, ?=-1, n=0**	**y**
301	**Naturalized beyond native range**	**y = 1*multiplier (see Appendix 2), n= question 205**	**y**
302	**Garden/amenity/disturbance weed**	**n=0, y = 1*multiplier (see Appendix 2)**	**y**
303	**Agricultural/forestry/horticultural weed**	**n=0, y = 2*multiplier (see Appendix 2)**	
304	**Environmental weed**	**n=0, y = 2*multiplier (see Appendix 2)**	
305	**Congeneric weed**	**n=0, y = 1*multiplier (see Appendix 2)**	**n**
401	**Produces spines, thorns or burrs**	**y=1, n=0**	**n**
402	**Allelopathic**	**y=1, n=0**	
403	**Parasitic**	**y=1, n=0**	**n**
404	**Unpalatable to grazing animals**	**y=1, n=-1**	**n**
405	**Toxic to animals**	**y=1, n=0**	**n**
406	**Host for recognized pests and pathogens**	**y=1, n=0**	
407	**Causes allergies or is otherwise toxic to humans**	**y=1, n=0**	**n**
408	**Creates a fire hazard in natural ecosystems**	**y=1, n=0**	**n**
409	**Is a shade tolerant plant at some stage of its life cycle**	**y=1, n=0**	**y**
410	**Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)**	**y=1, n=0**	**y**
411	**Climbing or smothering growth habit**	**y=1, n=0**	**n**

412	**Forms dense thickets**	**y=1, n=0**	**y**
501	**Aquatic**	**y=5, n=0**	**n**
502	**Grass**	**y=1, n=0**	**n**
503	**Nitrogen fixing woody plant**	**y=1, n=0**	**n**
504	**Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)**	**y=1, n=0**	**n**
601	**Evidence of substantial reproductive failure in native habitat**	**y=1, n=0**	**n**
602	**Produces viable seed**	**y=1, n=-1**	**y**
603	**Hybridizes naturally**	**y=1, n=-1**	**y**
604	**Self-compatible or apomictic**	**y=1, n=-1**	**n**
605	**Requires specialist pollinators**	**y=-1, n=0**	**n**
606	**Reproduction by vegetative fragmentation**	**y=1, n=-1**	
607	**Minimum generative time (years)**	**1 year = 1, 2 or 3 years = 0, 4+ years = -1**	**3**
701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**y=1, n=-1**	**n**
702	**Propagules dispersed intentionally by people**	**y=1, n=-1**	**y**
703	**Propagules likely to disperse as a produce contaminant**	**y=1, n=-1**	**n**
704	**Propagules adapted to wind dispersal**	**y=1, n=-1**	**n**
705	**Propagules water dispersed**	**y=1, n=-1**	**y**
706	**Propagules bird dispersed**	**y=1, n=-1**	**y**
707	**Propagules dispersed by other animals (externally)**	**y=1, n=-1**	**n**
708	**Propagules survive passage through the gut**	**y=1, n=-1**	**y**
801	**Prolific seed production (>1000/m2)**	**y=1, n=-1**	**y**
802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y=1, n=-1**	**n**
803	**Well controlled by herbicides**	**y=-1, n=1**	**y**
804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	**y=1, n=-1**	**y**
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	**y=-1, n=1**	

Designation: H(HPWRA) **WRA Score** **9**

Supporting Data:

101	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Is the species highly domesticated? No] "The naturalization of A. indica" in the countries adjacent to the Indian continent, which includes Thailand, some part of Malaysia, Java, and Bali (Now Indonesia) and probably east Africa, can be explained on the basis of the long cultural and commercial relations that these areas have had with India since ancient times." [no evidence that cultivation has modified species]
102	2011. WRA Specialist. Personal Communication.	NA
103	2011. WRA Specialist. Personal Communication.	NA
201	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Species suited to tropical or subtropical climate(s) 2-high] "There is much confusion in the literature about the natural distribution of A. indica. It is considered to be native to dry areas in India, Pakistan, Myanmar, Sri Lanka, Afghanistan, Bangladesh and China (Abdulla, 1972; Tewari, 1992; Vietmeyer, 1992; Gupta, 1993). In India and Pakistan, A. indica occurs naturally in dry deciduous and thorn forests (Champion et al., 1965). It is cultivated as well as naturalized in Thailand, Malaysia and Indonesia."
202	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Quality of climate match data? 2-high] "It is considered to be native to dry areas in India, Pakistan, Myanmar, Sri Lanka, Afghanistan, Bangladesh and China"
203	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Broad climate suitability (environmental versatility)? Yes] "Its altitudinal range is 0-1500 m ...Commonly known as 'neem', A. indica can be grown under a range of climatic and soil conditions...A. indica has wide climatic adaptability and thrives under sub humid to semi-arid and arid climatic conditions. It grows at temperatures as low as 1°C to as high as 49°C (Siddiqui, 1995). It is generally found in localities with mean maximum temperature of 26-38°C, mean minimum temperature of 24-28°C and mean annual temperature of 24-32°C, and in arid and subtropical ecological zones with a mean annual rainfall of 450-1150 mm. However, in the Thar Desert of Pakistan, A. indica tolerates as little rainfall as 113 mm per year (Siddiqui, 1995)." [Demonstrates environmental versatility]
204	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Native or naturalized in regions with tropical or subtropical climates? Yes] "distribution: India (native); South East Asia, East Africa, Caribbean Islands, Queensland, California, South Florida (introduced)"
204	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Native or naturalized in regions with tropical or subtropical climates? Yes] "There is much confusion in the literature about the natural distribution of A. indica. It is considered to be native to dry areas in India, Pakistan, Myanmar, Sri Lanka, Afghanistan, Bangladesh and China (Abdulla, 1972; Tewari, 1992; Vietmeyer, 1992; Gupta, 1993). In India and Pakistan, A. indica occurs naturally in dry deciduous and thorn forests (Champion et al., 1965). It is cultivated as well as naturalized in Thailand, Malaysia and Indonesia."
205	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Does the species have a history of repeated introductions outside its natural range?? Yes] "Introduced to various countries in South East Asia, East Africa, Caribbean Islands, Queensland of Australia, California & South Florida of USA. "
205	2011. Simberloff, D./Rejmánek, M.. Encyclopedia of Biological Invasions. University of California Press, Berkeley & Los Angeles	[Does the species have a history of repeated introductions outside its natural range? Yes] "Prosopis spp., Acacia nilotica, and Azadirachta indica (neem) have all been introduced into many countries outside their native home range, and are all invasive."
301	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Naturalized beyond native range? Yes] " The naturalization of A. indica" in the countries adjacent to the Indian continent, which includes Thailand, some part of Malaysia, Java, and Bali (Now Indonesia) and probably east Africa, can be explained on the basis of the long cultural and commercial relations that these areas have had with India since ancient times."
301	2007. Hussey, B.M.J./Keighery, G. J./Dodd, J./Lloyd, S.G./Cousens, R.D.. Western Weeds. A Guide to the Weeds of Western Australia. The Weed Society of Western Australia, Victoria Park, WA	[Naturalized beyond native range? Yes] "It has already naturalised along 80 km of the Ord River and is becoming a major woody weed in the tropics." [Western Australia]

301	2010. Silayo, D.S.A./Kiwango, H.R.. Management of Invasive Plants in Tropical Forest Ecosystems: Trials of Control Methods of Azadirachta indica. World Applied Sciences Journal. 10(12): 1414-1424.	[Naturalized beyond native range? Yes] "SANAPA constitutes what formerly were Mkwanja Ranch and the Saadani Game Reserve. The transition happened in 2002, two years after Mkwanja Ranch, then owned by a Swiss company (Amboni Ltd) closed down. The ranch was in existence since 1954. The neem plant and other alien plants were introduced as shade and ornamental plants in residential areas of the Mkwaja cattle ranch. The neem plant has since spread, becoming more abundant and widespread across the Park. Although the exact date for the neem introduction is not known, the abandonment of the ranch for some years facilitated its spread. Today, neem and all other alien plants in the park, are an eyesore to visitors and a threat to the existence of native species. As such, a combination of control methods and a strong scientific approach are required to successfully control the species in Saadani National Park. Generally the study aimed at establishing the best control methods of Azadirachta indica (Neem)." [Tanzania]
302	2004. Richardson, D.M./Binggeli, P./Schroth, G.. Invasive agroforestry trees: problems and solutions. Pp. 371-396 in Schroth, G. et al. (eds.) Agroforestry and biodiversity conservation in tropical landscapes. Island Press, Washington, D.C.	[Garden/amenity/disturbance weed? Yes] "Azadirachta indica is native to Southeast Asia and India but has been widely planted outside its range. It is known to be invasive in Ghana (http://www.green.ox.ac.uk/cnrd/jo.htm#darw n), spreads from rural plantings into undisturbed bush in northern Australia (A. A. Mitchell, pers. comm., 2002), and is also listed as a potential environmental weed in Australia (Cshurhes and Edwards 1998). Although various sources list A. indica as “weed,” “naturalized,” “garden escape,” or “environmental weed” (Randall 2002)."
302	2004. Wilson, G.W./Waterhouse, B.M./Werren, G.L.. The use of exotic species in dry tropics forestry: assessments, potential conflicts of interests and the application of The Precautionary Principle. http://www.plantations2020.com.au/reports/pfnq/acrobat/2	[Garden/amenity/disturbance weed? Yes] "In addition, Neem, Azadirachta indica A. Juss. (MELIACEAE) (syn. Melia azadirachta L.), until recently promoted by the QDPI and planted as an amenity species at several locations in the dry tropics of Queensland, has established as a weed species on the Gilbert River system and about Normanton in the Gulf Plains bioregion. Of these species C. velutina and A. indica are listed by Csurhes and Edwards (1998) and noted as having a weed history overseas."
302	2007. Hussey, B.M.J./Keighery, G. J./Dodd, J./Lloyd, S.G./Cousens, R.D.. Western Weeds. A Guide to the Weeds of Western Australia. The Weed Society of Western Australia, Victoria Park, WA	[Garden/amenity/disturbance weed? Yes. Potentially an environmental weed] "Neem is being promoted as a plantation tree for the production of natural insecticides, and is spreading rapidly into cultivated land, native woodlands and grasslands at Kununurra and Broome. It has already naturalized along 80 km of the Ord River and is becoming a major woody weed in the tropics."
302	2008. Csurhes, S.. Pest plant risk assessment: Neem tree Azadirachta indica. Biosecurity Queensland, Brisbane, Qld	[Garden/amenity/disturbance weed? Yes] "this study only found limited evidence that neem is a major weed overseas. While it has escaped cultivation and become naturalised in a number of countries, its impact is poorly documented." [also see 3.04]
303	2007. Randall, R.P.. Global Compendium of Weeds - Azadirachta indica [Online Database]. http://www.hear.org/gcw/species/azadirachta_indica/	[Agricultural/forestry/horticultural weed? Potentially] listed as an agricultural weed in Canada [no information on impacts]
304	2007. Low, T./Booth, C.. The Weedy Truth About Biofuels. The Invasive Species Council, Melbourne	[Environmental weed? Potentially] "Weed status: In recent years neem has emerged as a serious weed in the dry tropics of northern Australia. In a recent article published by the Weeds CRC, ‘Neem - miracle tree or ecological menace?’, there is a call for immediate action to prevent further spread of this tree. Neem has become a prolific weed along the Gilbert River in the Gulf of Carpentaria, along the Victoria River in the Northern Territory, along the Ord River in Western Australia, and around Broome. Its seeds are spread down watercourses, and by fruit-eating birds such as bowerbirds. According to CSIRO scientist Tony Grice: “There is a need for immediate policy measures and actions to remove the risk of further infestations developing, to document the scale of current infestations, and put in place strategies for containment or, where possible, eradication.”
304	2008. Csurhes, S.. Pest plant risk assessment: Neem tree Azadirachta indica. Biosecurity Queensland, Brisbane, Qld	[Environmental weed? Potentially] "There is some evidence that neem extracts can affect certain aquatic life including fish and tadpoles (NRC 1992) and some speculation that chemical compounds leached out of neem leaf litter might affect aquatic wildlife. There is also concern over the plant’s potential impact on native insect populations (Lonsdale 1999, pers. comm.)" [no information on negative impacts at this point, but sufficient evidence to answer "Yes" to 3.02]
304	2010. Radji, R./Klu, K./Kokou, K.. Forest invasion by alien plant species: The case of neem tree (Azadirachta indica A. Juss.) in Southern Togo. International Journal of Biodiversity and Conservation. 2(10): 300-307.	[Environmental weed? Potentially] "This study conducted in the forest fragments in the Southern Togo (Kokou and Sokpon, 2006; Kokou and Kokutse, 2007) made it possible to show how the neem tree threats these forest areas that are the only forest remnants in this part of Togo, fully open and dominated by crops, fallow lands and savannas (White, 1986). The overall objective of the study is to show the invasion of the forest flora of Southern Togo by alien species."

305	2007. Randall, R.P.. Global Compendium of Weeds - Index [Online Database]. http://www.hear.org/gcw/	[Congeneric weed? No] No evidence
401	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Produces spines, thorns or burrs? No] "A. indica is a medium to large, deep rooted tree. It is almost evergreen and has wide spreading branches forming a rounded or oval dense crown. It grows to a height of 12-15 m, in rare cases up to 30 m, with a short, straight bole 3-7.5 m long and 1.5-2.8 m in girth. The tree generally branches early in life, forming a broad round crown of bright green foliage. A. indica has moderately thick bark (1.2-2.5 cm) with small tubercles scattered between numerous longitudinally and obliquely wrinkled furrows. The bark is dark-grey from the outside and reddish inside."
402	1990. Alam, S.M.. Effect of wild plant extracts on germination and seedling growth of wheat. Rachis. 9(2): 12-13.	[Allelopathic? Potentially, although evidence only from lab, Field evidence lacking] "The effects of Cassia angustifolia, Sphaeranthus indicus and Azadirachta indica leaf extracts on wheat cv. Sarsabz seed germination and seedling growth were investigated. Germination was unaffected by the extracts but shoot growth was significantly increased by increasing extract concentration. C. angustifolia showed the largest increase (40%) followed by A. indica (30%) and S. indicus (12%). Root growth was decreased significantly as extract concentration increased."
402	2000. Gurusamy, A./Kathiresan, R./Ganesaraja, V./Raveendran, M.. Allelopathic potential of paddy seeds and some plant products on barnyard grass. Journal of Phytological Research. 13(1): 89-90.	[Allelopathic? Potentially, although evidence only from lab, Field evidence lacking] "B: The allelopathic effects of rice seeds, neem (Azadirachta indica) cake, sugarcane press mud and press mud slurry on the growth and establishment of Echinochloa crus-galli were determined. Soaking E. crus-galli seeds with rice seeds resulted in increased germination percentage compared to the control (water soaked), but all other treatments decreased the dry matter accumulation and germination of E. crus-galli seeds. "
403	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Parasitic? No] "A. indica is a medium to large, deep rooted tree." [Meliaceae. Not known to be parasitic]
404	1990. Koul, O./Isman, M.B./Ketkar, C.M.. Properties and uses of neem, Azadirachta indica. Canadian Journal of Botany. 68(1): 1-11.	[Unpalatable to grazing animals? No] "The versatility of the neem tree Azadirachta indica A. Juss. is reviewed. This species, native to India, grows in nutrient-poor soils in arid habitats and has tremendous potential for human use. Various derivatives of the tree have potential use in toiletries, pharmaceuticals, the manufacture of agricultural implements and furniture, cattle and poultry feeds, nitrification of soils for various agricultural crops, and pest control. Since neem is a natural renewal resource producing extensive useful biomass, its propagation and economic exploitation will be beneficial, particularly to the Third World. In recent years, some useful commercial products have been developed from A. indica, and mere is considerable scope for future product development. Potentially profitable lines of research on this plant species are suggested."
404	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Unpalatable to grazing animals? No] "In Nigeria, damage to A. indica by several species of mammals has been reported. Browsing by domestic goats, Capra hircus, damages plantings. The red flanked duiker, Cephalophus rufilatus, occasionally causes slight bark damage. The Nigerian hare, Lepus crawshayi, is suspected of eating the tops of seedlings in forest nurseries (Hocking, 1993; Pirani, 1994)."
405	2004. Boeke, S.J./Boersma, M.G./Alink, G.M./van Loon, J.J.A./van Huis, A./Dicke, M./Rietjens, I.M.C.M.. Safety evaluation of neem (Azadirachta indica) derived pesticides. Journal of Ethnopharmacology. 94: 25–41.	[Toxic to animals? No] "The neem tree, Azadirachta indica, provides many useful compounds that are used as pesticides and could be applied to protect stored seeds against insects...From the available data, safety assessments for the various neem-derived preparations were made and the outcomes are compared to the ingestion of residues on food treated with neem preparations as insecticides. This leads to the conclusion that, if applied with care, use of neem derived pesticides as an insecticide should not be discouraged."
405	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Toxic to animals? No] "In Nigeria, damage to A. indica by several species of mammals has been reported. Browsing by domestic goats, Capra hircus, damages plantings. The red flanked duiker, Cephalophus rufilatus, occasionally causes slight bark damage. The Nigerian hare, Lepus crawshayi, is suspected of eating the tops of seedlings in forest nurseries (Hocking, 1993; Pirani, 1994)."

406	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Host for recognized pests and pathogens? Potentially] "Damping off affects germinating seedlings under conditions of excessive moisture. In India, up to 20% seedling mortality has been reported in nurseries at New Forest, Dehra Dun. The fungus Fusarium oxysporum is generally associated with diseased seedlings (Pirani, 1994; Siddiqui, 1995). Several fungi that attack foliage can cause damage in nurseries. Rhizoctonia leaf web blight is caused by the fungus Rhizoctonia solani, and forms grey-brown spots on foliage. Infected leaves are joined together by fungus hyphae, as if caught in a spider's web. This disease is common in nurseries after the monsoon rains begin. Infection by Glomerella cingulata, also results in leaf spots that rapidly increase in size and cover large areas of foliage surface. Other fungi that damage foliage in nurseries are Alternaria alternata and Pseudocercospora subsessilis. Several bacteria, including Pseudomonas viticola, P. azadirachtae and Xanthomonas azadirachtii, cause leaf spot diseases (Tewari, 1992). Root rot is caused by the fungus Ganoderma lucidum. This fungus has a worldwide distribution and a broad host range. Sporadic infections occur in young plantings of this species when stumps and roots of the previous tree crop are not removed from the site. The fungus attacks the sapwood and causes a white spongy rot. Symptoms of infection are pale, thin foliage and branch dieback. Fruiting bodies often occur at the base of the stem (Vietmeyer, 1992; Pirani, 1994). A. indica is one of many plants affected by pink disease caused by the fungus Corticium salmonicolor. This disease can cause serious damage, especially under tropical conditions (Hocking, 1993). The earliest sign of infection is the presence of white or pink pustules on dead bark. A conspicuous pink layer of fungus mycelium spreads over the bark. In time, the bark may be entirely destroyed and the outer layers of wood killed. Branches are killed quickly causing the foliage to wilt and turn black. The fungus Botryodiplodia theobromae is associated with weeping cankers and dieback of neem in Niger (Boa, 1995). A. indica is one of many hosts of the mistletoe Dendrophthoe falcata, which is widely distributed in the Indo-Pakistan subcontinent and the Solomon Islands. Another mistletoe of the genus Tapinanthus also infests neem and other trees in Nigeria (Boa, 1995, Pirani, 1994; Luna, 1996). This mistletoe is capable of killing branches and causing deformity. A decline of neem, due to a complex of factors, has been reported from several countries in West Africa. The most conspicuous symptom associated with this condition is loss of older foliage, which is often preceded by yellowing of older leaves. Foliage loss gives tree crowns an open appearance with clumps of leaves concentrated at the branch tips. This symptom has been termed "giraffe's neck" (Boa, 1992, Ciesla 1993). Neem decline was first reported from Niger in 1990 but was subsequently observed in northern Nigeria, Chad and the Cameroon (Boa, 1995). The condition was probably related to long-term moisture stress. Symptoms were significantly reduced following the 1994-95 rainy season, which was much heavier than previous years (WM Ciesla, Forest Health Management International, Colorado, USA, personal communication, 2004)."
407	2004. Boeke, S.J./Boersma, M.G./Alink, G.M./van Loon, J.J.A./van Huis, A./Dicke, M./Rietjens, I.M.C.M.. Safety evaluation of neem (Azadirachta indica) derived pesticides. Journal of Ethnopharmacology. 94: 25–41.	[Causes allergies or is otherwise toxic to humans? No] No evidence
407	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Causes allergies or is otherwise toxic to humans? No] No evidence
408	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Creates a fire hazard in natural ecosystems? No]
409	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is a shade tolerant plant at some stage of its life cycle? Yes] "A. indica is a light demander but it also tolerates fairly heavy shade during its early development."
410	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Tolerates a wide range of soil conditions? Yes] " The tree grows on a variety of soils, clayey or sandy, saline or alkaline. It does particularly well, however, on black cotton soils and deep, well drained soils with good subsoil water. Unlike most other multipurpose tree species, A. indica thrives on dry, stony, shallow soils and even on soils with hard calcareous or clay pans at a shallow depth (Tewari, 1992)."
411	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Climbing or smothering growth habit? No] "A. indica is a medium to large, deep-rooted tree."

412	1999. Decher, J./Bahian, L.K.. Diversity and structure of terrestrial small mammal communities in different vegetation types on the Accra Plains of Ghana. Journal of Zoology Journal of Zoology. 247: 395-408.	[Forms dense thickets? Yes] "Only dense stands of the invading neem tree (Azadirachta indica) may adversely affect small mammals. These stands develop in savanna thickets and riverine vegetation but are artificially kept under control in Shai Hills Resource Reserve. In patchy habitat disturbed by fire and spreading neem trees, as on the slope of Shai Hills Resource Reserve, small mammal diversity increases, but population sizes and biomass decrease compared to undisturbed dry forest, high forest remnants, and secondary fire-protected forests. Although unequivocal evidence for a `neem effect' on small mammals is still wanting, we caution against the uncritical promotion of this exotic tree in West African savanna especially in or near areas that are set aside to protect the natural flora and fauna of the region." [Dense stands of Azadirachta may reduce diversity]
412	2006. Attuquayefio, D.K./Ryan, J.M.. Taxonomic Report on Small Mammals from Two Coastal Wetland (Ramsar) Sites in Ghana. West African Journal of Applied Ecology. 10: 26-35.	[Forms dense thickets? Yes] "The area comprises tall grasses and sedges interspersed with small A. indica (neem) thickets." [Ghana]
501	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Aquatic? No] "A. indica is a medium to large, deep-rooted tree." [Terrestrial]
502	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Grass? No] Meliaceae
503	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Nitrogen fixing woody plant? No] Meliaceae
504	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "A. indica is a medium to large, deep-rooted tree."
601	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Evidence of substantial reproductive failure in native habitat? No] No evidence
602	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Produces viable seed? Yes] "A. indica is frequently self-sown in gardens and the areas around mature trees are quickly colonized by a carpet of seedlings. It has the ability to establish itself under the protection of thorny bushes and to survive in dry poor soils, provided it is not subjected to frost (Tewari, 1992)."
602	2005. Staples, G.W./Herbst, D.R.. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	[Produces viable seed? Yes] "It is easily propagated by seed or terminal cuttings."
603	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Hybridizes naturally? Yes] "In some areas, hybridization has occurred between A. indica and A. siamensis"
604	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Self-compatible or apomictic? See Vikas and Tandon 2011] "The flowers are cross-pollinated in general, in spite of bisexual flowers and the absence of self-incompatibility."
604	2011. Vikas/Tandon, R.. Reproductive biology of Azadirachta indica (Meliaceae), a medicinal tree species from arid zones. Plant Species Biology. 26: 116–123.	[Self-compatible or apomictic? No] "Although the occurrence of incomplete dichogamy and a pollen : ovule ratio of ~ 627 indicates the possibility of autogamy, supplemental pollinations clearly established that the trees were 100% self-incompatible and incompatibility is regulated at the gametophytic level. Natural fruit set was low (~ 5%) and hand cross-pollinations increased the fruit set to ~ 19%. Our study demonstrated that natural fruit set in Neem is possibly limited by insufficient amounts of xenogamous pollination and resources." [Recent research refutes Puri 1999]
605	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Requires specialist pollinators? No] "The flowers are cross-pollinated in general, in spite of bisexual flowers and the absence of self-incompatibility. Pollination is occasionally entomophilous but usually anemophilous." [Wind and insect pollinated]
605	2011. Vikas/Tandon, R.. Reproductive biology of Azadirachta indica (Meliaceae), a medicinal tree species from arid zones. Plant Species Biology. 26: 116–123.	[Requires specialist pollinators? No] "The occurrence of natural pollination both by wind and insects indicates ambophily. Insect pollinators were predominantly represented by Hymenoptera and Lepidoptera; Apis spp. were the most effective pollinators."
606	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Reproduction by vegetative fragmentation? Potentially] "Ability to sucker; regenerate rapidly; coppice; pollard" [ability to sucker, but no indication of how far from source tree]

606	2010. Dharani, N./Rukunga, G./Yenesew, A./Mbora, A./Mwaura, L./Dawson, I./Jamnadass, R.. Common AntimalarialTrees & Shrubs of East Africa: a Description of Species & a Guide to Cultivation & Conservation Through Use. The World Agroforestry Centre (ICRAF),	[Reproduction by vegetative fragmentation? Potentially] "Neem wildlings are an inexpensive source of planting material, as natural regeneration is often abundant. Neem trees produce root suckers which mean that propagation is possible using root cuttings."
607	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Minimum generative time (years)? 3+] "Gupta et al. (1995) studied the time of flowering and fruiting in a provenance trial of a neem population of tree year-old trees."
607	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Minimum generative time (years)? 3+] "The tree starts fruiting at an age of about 5 years, but economic yield of fruit is obtained at an age of 10-12 years."
701	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? No] "The fruit of A. indica is a drupe, 12-18 mm long, ovoid-oblong, yellowish-green, smooth dark-yellow when ripe. The walls break down from the mucilaginous mesocarp. The endocarp is thin, cartilaginous, with inter cellular space between the epicarp and endocarp. The seeds are 1-2 reticulate. The outer seed coat has thick walled epidermis and three layers of loosely arranged cells, with the cell of the inner integument elongating tangentially to form the inner seed coat (Parker, 1956; Tewari, 1992)." [Fruit & seeds with no means of external attachment]
702	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules dispersed intentionally by people? Yes] "A. indica, grown pantropically, has received worldwide attention in recent years. It is considered to be a 'wonder' tree with an unlimited number of uses. A report prepared by an ad hoc advisory panel has called it 'a tree for solving global problems' (Vietmeyer, 1992). The tree has great religious, economic, medicinal and ornamental value, and nearly every part of the tree (roots, trunk, bark, leaves, flowers, fruits and seeds) can be used for some purpose (Tewari, 1992; Luna, 1996)."
703	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules likely to disperse as a produce contaminant? No] "The fruit of A. indica is a drupe, 12-18 mm long, ovoid-oblong, yellowish-green, smooth dark-yellow when ripe. The walls break down from the mucilaginous mesocarp. The endocarp is thin, cartilaginous, with inter cellular space between the epicarp and endocarp. The seeds are 1-2 reticulate. The outer seed coat has thick walled epidermis and three layers of loosely arranged cells, with the cell of the inner integument elongating tangentially to form the inner seed coat (Parker, 1956; Tewari, 1992)." [no evidence that fairly large fruits/seeds are contaminants of produce]
704	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules adapted to wind dispersal? No] "The fruit of A. indica is a drupe, 12-18 mm long, ovoid-oblong, yellowish-green, smooth dark-yellow when ripe." [Fleshy-fruited, with no adaptations for wind dispersal]
705	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Propagules water dispersed? Yes] "Most of the seed fall on the ground under the tree, where at that time the soil is water logged or there may be rain streams. The fruit may remain in moist conditions under the tree or occasionally may travel some distance with rain water."
705	2006. Grice, A.C.. Commercially valuable weeds: Can we eat our cake without choking on it?. Ecological Management & Restoration. 7: 40–44.	[Propagules water dispersed? Yes] "Finally, the risk of naturalization of commercial weeds may be reduced by controlling the location of plantings. This would involve locating plantings away from sites that are especially suitable for the target species. An example of such an approach would be ensuring that Neem plantations in northern Australia are sited away from the riparian zones that appear particularly susceptible to invasion by this species (Grice 2002)."
705	2007. Low, T./Booth, C.. The Weedy Truth About Biofuels. The Invasive Species Council, Melbourne	[Propagules water dispersed? Yes] "Neem has become a prolific weed along the Gilbert River in the Gulf of Carpentaria, along the Victoria River in the Northern Territory, along the Ord River in Western Australia, and around Broome. Its seeds are spread down watercourses, and by fruit-eating birds such as bowerbirds."
706	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Propagules bird dispersed? Yes] "Occasionally, some fruits are swallowed by birds for their sweet pulp and the seeds are passed out of the body, undigested, because of the hard endocarp. The seeds so dropped are far away from the trees; if they germinate, the seedlings have much better chances of surviving and producing plants, as compared to undispersed seed."
706	2000. Gandhi, T.. Birds and plant regeneration. Orient Blackswan, New Delhi	[Propagules bird dispersed? Yes] "The Neem's fruit is golden yellow when ripe and is eaten by koels, crows, bulbuls and mynas which disperse the seeds afar."
706	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules bird dispersed? Yes] "Birds and bats play an important role in dispersal of its seed. The fruit ripening period coincides with the rainy season, and under natural conditions, the fruit falls on the ground and germinates within 15 days. It has been recorded that germination is enhanced by passage through the guts of baboons (Mabberley, 1997)."

706	2006. Bedell, P.. Tree breeding for genetic improvement of tropical tree species. Allied Publishers, New Delhi	[Propagules bird dispersed? Yes] "Some fruits are eaten by various birds and animals, e.g. fruits of Azadirachta indica are eaten by crows…"
706	2010. Radji, R./Klu, K./Kokou, K.. Forest invasion by alien plant species: The case of neem tree (Azadirachta indica A. Juss.) in Southern Togo. International Journal of Biodiversity and Conservation. 2(10): 300-307.	[Propagules bird dispersed? Yes] "Field observations have shown that the fruits of A. indica are eaten by birds and the seeds are disseminated in the ecosystems. This ease of dissemination accounts for the high frequency observed for this species, especially in the juvenile population."
707	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules dispersed by other animals (externally)? No] "The fruit of A. indica is a drupe, 12-18 mm long, ovoid-oblong, yellowish-green, smooth dark-yellow when ripe. The walls break down from the mucilaginous mesocarp. The endocarp is thin, cartilaginous, with inter cellular space between the epicarp and endocarp. The seeds are 1-2 reticulate. The outer seed coat has thick walled epidermis and three layers of loosely arranged cells, with the cell of the inner integument elongating tangentially to form the inner seed coat (Parker, 1956; Tewari, 1992)." [Fruit & seeds with no means of external attachment]
708	1979. Lieberman, D./Hall, J.B./Swaine, M.D./Lieberman, M.. Seed Dispersal by Baboons in the Shai Hills, Ghana. Ecology. 60(1): 65-75.	[Propagules survive passage through the gut? Yes] "Baboon dung was collected in the Shai Hills, Ghana at 4-wk intervals from November 1975 to January 1977, and was planted in sterilized soil in order to estimate the viable seed content of the dung. A total of 6,465 seedlings germinated, belonging to 59 species, although 70w of the seedlings belonged to 2 fleshy-fruited species. The species composition varied from month to month as did the relative importance of dry fruits. Germination of ingested seeds (removed from dung) was significantly improved over that of fresh seeds in 3 of 4 species tested (Securinega virosa, Azadirachta indica, and Nauclea latifolia). The 4th species, Diospyros mespiliformis, showed no significant improvement."
708	1999. Puri, H.S.. Neem: the divine tree : Azadirachta indica. Taylor & Francis Group, London	[Propagules survive passage through the gut? Yes] "Occasionally, some fruits are swallowed by birds for their sweet pulp and the seeds are passed out of the body, undigested, because of the hard endocarp."
801	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Prolific seed production (>1000/m2)? Yes] "There are 3300-4500 seeds per kilogram, and on average a medium-sized tree produces 37-55 kg of fruit"
801	2008. Csurhes, S.. Pest plant risk assessment: Neem tree Azadirachta indica. Biosecurity Queensland, Brisbane, Qld	[Prolific seed production (>1000/m2)? Yes] "Since neem is estimated to produce 44 000–200 000 bird-dispersed seeds each year, its spread might be rapid."
802	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Evidence that a persistent propagule bank is formed (>1 yr)? No] "A. indica is propagated primarily through seed. The seeds are recalcitrant and are shed at relatively high moisture content, hence are prone to dehydration and chilling injuries (Mishra, 1995). They have a short viability of 3-4 weeks. Seeds stored at 4°C show a high germination percentage. To maintain viability of the seeds, the drupes must be cleaned properly by depulping, either manually or mechanically under a stream of water to provide stones...The short viability of the seed and different ripening times in various localities is a serious problem and poses logistic difficulties for the introduction of this species to new locations."
802	2010. Dharani, N./Rukunga, G./Yenesew, A./Mbora, A./Mwaura, L./Dawson, I./Jamnadass, R.. Common AntimalarialTrees & Shrubs of East Africa: a Description of Species & a Guide to Cultivation & Conservation Through Use. The World Agroforestry Centre (ICRAF),	[Evidence that a persistent propagule bank is formed (>1 yr)? No] "Although neem is a prolific seeder, seed availability is frequently a problem. The viability of fresh seed decreases rapidly two weeks after collection unless it is stored correctly; seed can be stored for up to four months if kept at 4^0C."
803	2010. Silayo, D.S.A./Kiwango, H.R.. Management of Invasive Plants in Tropical Forest Ecosystems: Trials of Control Methods of Azadirachta indica. World Applied Sciences Journal. 10(12): 1414-1424.	[Well controlled by herbicides? Yes] "Abstract: This study was conducted in Saadan National Park to establish the best control methods of Azadirachta indica in the tropical forests. Tested methods included; ring debarking, cutting, seedling uprooting and stem injection with glyphosate herbicide...All the cut steams sprouted into multiple shoots. All chemical treated trees died. Stem injection with glyphosate was found to be more effective than other control methods tested."
804	1992. Vietmeyer, N.D. (ed.). Neem: a tree for solving global problems. National Academy Press, Washington, D.C.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "Neem can take considerable abuse. For example, it easily withstands pollarding (repeated lopping at heights above about 1.5 m) and its topped trunk resprouts vigorously. Regrowth from both pollarding and coppicing can be exceptionally fast because it is being served by a root system large enough to feed a full-grown tree."
804	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "A. indica is seldom found growing gregariously. It regenerates naturally and is propagated mainly through seed. It also regenerates well by coppicing and pollarding, and can produce root suckers, especially in dry localities (Vietmeyer, 1992; Luna, 1996)."

804	2010. Dharani, N./Rukunga, G./Yenesew, A./Mbora, A./Mwaura, L./Dawson, I./Jamnadass, R.. Common AntimalarialTrees & Shrubs of East Africa: a Description of Species & a Guide to Cultivation & Conservation Through Use. The World Agroforestry Centre (ICRAF),	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "Neem seedlings should also be protected from fire, although mature trees can recover from fire damage."
805	2011. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]