

Taxon: <i>Arenga pinnata</i> (Wurmb) Merr.	Family: Arecaceae
Common Name(s): areng palm black-fiber palm sugar palm	Synonym(s): <i>Arenga gamuto</i> (Houtt.) Merr. <i>Arenga griffithii</i> Seem. ex H. Wendl. <i>Arenga saccharifera</i> Labill. ex DC. <i>Borassus gomutus</i> Lour. <i>Caryota onusta</i> Blanco <i>Gomutus rumphii</i> Corrêa <i>Gomutus saccharifer</i> (Labill. ex DC.) <i>Gomutus vulgaris</i> Oken <i>Saguerus gamuto</i> Houtt. <i>Saguerus pinnatus</i> Wurmb <i>Saguerus rumphii</i> (Corrêa) Roxb. <i>Saguerus saccharifer</i> (Labill. ex DC.) <i>Sagus gomutus</i> (Lour.) Perr.

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 13 Mar 2020
WRA Score: 12.0	Designation: H(HPWRA)	Rating: High Risk

Keywords: Naturalized Palm, Weedy, Spiny, Dense Stands, Animal-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
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)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	y

Qsn #	Question	Answer Option	Answer
305	Congeneric weed		
401	Produces spines, thorns or burrs	y=1, n=0	y
402	Allelopathic	y=1, n=0	n
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals		
406	Host for recognized pests and pathogens	y=1, n=0	n
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	y
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		
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
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		
706	Propagules bird dispersed	y=1, n=-1	y
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)		
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	n

Qsn #	Question	Answer Option	Answer
803	Well controlled by herbicides		
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 12 Mar 2020]	"History of cultivation Although the origin of <i>A. pinnata</i> is not known with certainty, it may be from the region of Minahassa in North Sulawesi, Indonesia, in view of the great abundance of this palm at all sites. As early as 1821 it was reported that 439 450 sugar palms were harvested for ijuk (black fibres), yielding as much as 300 000 ropes from a single factory during one month. At that time the sea water-resistant fibres were the main product, as in the extensive sugar palm plantings in Malacca in the 19th century. Its great versatility makes it one of the oldest cultivated plants, and it was probably a source of plant sugar long before sugarcane was cultivated for that purpose. Among the Minahassa, for example, legends about the use of the 'toddy' date back to the time of Toar and Lumimuut, who were the first human beings on earth, according to their traditional belief." [Long history of cultivation, but no significant changes by domestication known]
	Duke, J.A. (2000). <i>Handbook of Nuts</i> . CRC Press, Boca Raton, FL	"Several forms of the sugar palm exist in Malaya, varying mainly in how long is required for plants to begin flowering" [Could affect ability to naturalize, but otherwise, domestication does not seem to have significantly altered tree to point of becoming potentially less invasive]
	Janick, J.& Paull, R.E. 2008. <i>The Encyclopedia of Fruit and Nuts</i> . CABI Publishing, Wallingford, UK	"While some degree of regional selection has been applied to sugar palm, mostly towards reducing the juvenile period, no rigorous breeding or cultivar evaluation programme has ever been conducted."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	NA

Qsn #	Question	Answer
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	High
	Source(s)	Notes
	Chan, E. & Tettoni, L.I. (1998). Tropical Plants. Tuttle Publishing, North Clarendon, VT	"Arenga pinnata is the sugar palm of Malaysia and Java that is said to give a rich sugar Indigenous to Southeast Asia, it grows wild, but is sometimes cultivated."
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 12 Mar 2020]	"Native Asia-Tropical INDIAN SUBCONTINENT: India (e.) INDO-CHINA: Myanmar, Thailand, Vietnam MALESIA: Indonesia, Malaysia (Malaya), Philippines"

202	Quality of climate match data	High
	Source(s)	Notes
	Chan, E. & Tettoni, L.I. (1998). Tropical Plants. Tuttle Publishing, North Clarendon, VT	"Arenga pinnata is the sugar palm of Malaysia and Java that is said to give a rich sugar Indigenous to Southeast Asia, it grows wild, but is sometimes cultivated."

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Ranging from Subtropical Dry to Moist through Tropical Dry to Wet Forest Life Zones, sugar palm is reported to tolerate annual precipitation of 7 to 40 dm (mean of 8 cases = 19.1), annual temperature of 19 to 27 degrees C, (mean of 8 cases = 24.5), and pH of 5.0 to 8.0 (mean of 5 cases = 6.4). More or less a forest tree, but not restricted to jungles; it can be grown on very poor rocky hillsides and in waste places. It flourishes best in humid tropics in a rich moist soil, from sea-level to elevations of 1,200 m, being grown at higher elevations than coconut."
	Janick, J. & Paull, R.E. 2008. The Encyclopedia of Fruit and Nuts. CABI Publishing, Wallingford, UK	[Elevation range >1000 m] "Arenga pinnata is thought to have originated in Indonesia but is now widely distributed through India, Sri Lanka, southern China, Southeast Asia, New Guinea and Guam, from sea level to 1200 m elevation."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Chan, E. & Tettoni, L.I. (1998). Tropical Plants. Tuttle Publishing, North Clarendon, VT	"Arenga pinnata is the sugar palm of Malaysia and Java that is said to give a rich sugar Indigenous to Southeast Asia, it grows wild, but is sometimes cultivated."

Qsn #	Question	Answer
	<p>Parker, J.L. & Parsons, B. 2012. New Plant Records from the Big Island for 2010–2011. Bishop Museum Occasional Papers 113: 65-74</p>	<p>[Hawaii Island] "Sugar palm is a popular ornamental in the Hawaiian Islands and in its home range the male spadices are tapped for their sugary syrup which is made into a palm wine upon distillation (Mabberley 2008). This species has spread from 100+ year-old plantings in the Bond Historic Distr into the lower section of Waianaia Gulch, where mature flowering and fruiting trees were observed with many saplings. naturalized specimens of this plant have been collected on O'ahu (Daehler & Baker 2006: 5). Material examined. HAWAII: north Kohala Distr. Bond Historic Distr, Waianaia Gulch, 2236772n, 207675e. Large palm with fronds up to 9 m found in gulch in 'Iole ahupua'a. Large, flowering and fruiting population with black hairs and long spines on trunks, 6 Apr 2010, J. Parker & R. Parsons BIED115."</p>
	<p>Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18</p>	<p>[Oahu] "Native to Southeast Asia (probably Indonesia or Malaysia), the sugar palm is a large, single- trunked palm. The leaves are large (to 9 m), dark-green above, silvery below, with the long leaflets ragged at the tips. The trunk is covered by loose, brown-black fibrous material mixed with long, stiff, spinelike fibers. At maturity this palm flowers from the top down, eventually dying. The fruits are dark red, about 2.5 cm in diameter, and are extremely irritating to the skin, containing calcium oxalate crystals. First planted in the Arboretum in 1932. Naturalized plants around the Arboretum are probably in their third generation, and they form dense stands locally. Material examined: O'AHU: Naturalized plant growing on ridge in upper Haukulu, Lyon Arboretum; 25 Jul 2005, C. Daehler 1318 (HAW); Lyon Arboretum (cultivated material), 25 Jul 1968, F.B. Essig 680725 (HLA)."</p>

Qsn #	Question	Answer
205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Escapee References: Federated States of Micronesia-N-230, United States of America-CE-617, Africa-W-760, Global- W-307, Tanzania-I-970, Africa-W-990, United States of America-N-1114, United States of America-Q-1197, Global-W- 1376, Global-I-1404, Global-CD-1611, East Africa-I-1723, China-N-1796, Benin- N-1796, -I-, United States of America-N- 2092, Algeria-W-1977, Kenya-W-1977, Micronesia (Federated States of)-W-1977, Palau-W-1977, United Republic of Tanzania-W-1977."
	Dawson, W., Mndolwa, A. S., Burslem, D. F., & Hulme, P. E. (2008). Assessing the risks of plant invasions arising from collections in tropical botanical gardens. Biodiversity and Conservation, 17(8): 1979-1995	"Table 5 Spreading species with known planting history in ABG" [Includes <i>Arenga pinnata</i> . Cultivated and spreading in Tanzania]
	Dave's Garden. (2020). <i>Arenga pinnata</i> . https://davesgarden.com/guides/pf/go/62892/ . [Accessed 12 Mar 2020]	"This plant has been said to grow in the following regions: Tucson, Arizona Corte Madera, California Thousand Oaks, California Westminster, California Loxahatchee, Florida Naples, Florida Saint Petersburg, Florida"
	Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18	[Cultivated and naturalized in Hawaii] "First planted in the Arboretum in 1932. Naturalized plants around the Arboretum are probably in their third generation, and they form dense stands locally."

301	Naturalized beyond native range	y
	Source(s)	Notes
	Dawson, W., Mndolwa, A. S., Burslem, D. F., & Hulme, P. E. (2008). Assessing the risks of plant invasions arising from collections in tropical botanical gardens. Biodiversity and Conservation, 17(8): 1979-1995	"Table 5 Spreading species with known planting history in ABG... <i>Arenga pinnata</i> ...Naturalised or Invasive elsewhere: Yes"
	Hashim, N. R., Hughes, F., & Bayliss-Smith, T. (2010). Non-native species in floodplain secondary forests in peninsular Malaysia. Environment Asia, 3, 43-49	"Unlike the relatively recent introduction of cocoa, oil palm and <i>G. sepium</i> , four other species (sago, areca, <i>Arenga pinnata</i> and the tree bamboo) are all believed to have been introduced into the peninsula many centuries ago and are now considered naturalized." [Malaysia]
	Parker, J.L. & Parsons, B. 2012. New Plant Records from the Big Island for 2010–2011. Bishop Museum Occasional Papers 113: 65-74	[Hawaii Island] "Sugar palm is a popular ornamental in the Hawaiian Islands and in its home range the male spadices are tapped for their sugary syrup which is made into a palm wine upon distillation (Mabberley 2008). This species has spread from 100+ year-old plantings in the Bond Historic Distr into the lower section of Waianaia Gulch, where mature flowering and fruiting trees were observed with many saplings. naturalized specimens of this plant have been collected on O'ahu (Daehler & Baker 2006: 5). Material examined. HAWAII: north Kohala Distr. Bond Historic Distr, Waianaia Gulch, 2236772n, 207675e. Large palm with fronds up to 9 m found in gulch in 'Iole ahupua'a. Large, flowering and fruiting population with black hairs and long spines on trunks, 6 Apr 2010, J. Parker & R. Parsons BIED115."

Qsn #	Question	Answer
	Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18	[Oahu] "First planted in the Arboretum in 1932. Naturalized plants around the Arboretum are probably in their third generation, and they form dense stands locally. Material examined: O'AHU: Naturalized plant growing on ridge in upper Haukulu, Lyon Arboretum; 25 Jul 2005, C. Daehler 1318 (HAW); Lyon Arboretum (cultivated material), 25 Jul 1968, F.B. Essig 680725 (HLA)."

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	Starting to naturalize from gardens (see Daehler and Baker 2006) and spread into native forests (see question 3.04) but not currently regarded as a weed of gardens, or disturbance

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	WRA Specialist. (2020). Personal Communication	No evidence that <i>A. pinnata</i> has become a weed of agriculture, horticulture or forestry, but may have potential to become an environmental weed of wet forests.

Qsn #	Question	Answer
304	Environmental weed	y
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	" <i>Arenga pinnata</i> has the ability to invade forest gaps and forest understoreys, forming dense stands to the detriment of native plant species."
	Binggeli, P. 2000. The East Usambaras (Tanzania) - The Pearl of Africa. <i>Aliena</i> 10: 14-15	"Casual observations at two other locations indicate that other species, hitherto not thought to be invading, are also spreading into natural forest including two tree species, <i>Castilla elastica</i> and <i>Arenga pinnata</i> , and a bamboo."
	Meyer, J. Y., Lavergne, C., & Hodel, D. R. 2008. Time bombs in gardens: invasive ornamental palms in tropical islands, with emphasis on French Polynesia (Pacific Ocean) and the Mascarenes (Indian Ocean). <i>Palms</i> , 52(2): 71-83	"In 1999, Meyer officially advised the Department of the Environment of French Polynesia to ban introduction of <i>Licuala grandis</i> , <i>Washingtonia</i> spp. and <i>Elaeis guineensis</i> . All new importation of palms of the genera <i>Adonidia</i> , <i>Areca</i> , <i>Arenga</i> , <i>Borassus</i> , <i>Dypsis</i> , <i>Corypha</i> , <i>Howea</i> , <i>Livistona</i> , <i>Ptychosperma</i> and <i>Roystonea</i> , as well as <i>Elaeis guineensis</i> , <i>Washingtonia robusta</i> and <i>Phoenix dactylifera</i> , are officially illegal in French Polynesia Decree °276 CM 23 May 2005), primarily because of the risk of disease to the coconut, the most economically important plant of the islands."
	Aman, S. S. (2018). Effects of selected alien plants on recruitment of three native tree species in Amani botanical garden, Tanzania MSc Thesis. Sokoine University of Agriculture, Morogoro, Tanzania	[No saplings recruit under stands of <i>Arenga pinnata</i> and other species] "Similarly, this study did not record any sapling species under <i>Phyllostachys bambusoides</i> , <i>Psidium cattleianum</i> and <i>Arenga pinnata</i> due to high shade and thickness that could not allow light to penetrate to support life for other species. Ultimately has resulted the whole area to have a mono dominant form of vegetation that affects the ecosystem services. Equally, Rajaonarimamy et al. (2017) reported that invaded areas decreases diversity and abundance of native plants species."

305	Congeneric weed	
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	<i>Arenga engleri</i> , <i>Arenga obtusifolia</i> , <i>Arenga tremula</i> & <i>Arenga westerhoutii</i> cited as naturalized and/or weedy. Detrimental impacts of these species have not been verified.

401	Produces spines, thorns or burrs	y
	Source(s)	Notes
	Dave's Garden. (2020). <i>Arenga pinnata</i> . https://davesgarden.com/guides/pf/go/62892/ . [Accessed 12 Mar 2020]	"Danger: Plant has spines or sharp edges; use extreme caution when handling"
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"old leaf-bases covering trunk with a mat of tough, black fibers and long spines"

402	Allelopathic	n
	Source(s)	Notes

Qsn #	Question	Answer
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 12 Mar 2020]	"As the heavy shade and the dense root system of the sugar palm limit its combination with other crop plants, it is best planted on steeper slopes, easily eroding lands, or in single or double rows near the boundaries of fields, where it contributes to soil stabilization without taking up considerable land area" [But no evidence of allelopathy]
	Appiah, K., Li, Z., Zeng, R. S., Luo, S., Oikawa, Y., & Fujii, Y. (2015). Determination of allelopathic potentials in plant species in Sino-Japanese floristic region by sandwich method and dish pack method. <i>International Journal of Basic and Applied Sciences</i> , 4(4), 381-394	"Table 1: Radicle and hypocotyl elongation percentages of lettuce seedlings grown on agar gel containing oven-dried plant materials tested using the sandwich method." [<i>Arenga pinnata</i> evaluated for allelopathic potential, but effects were not significant]

403	Parasitic	n
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"A moderate to tall unbranched, hapaxanthic, solitary palm." [Areaceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	Notes
	Riley, E. P. (2007). Flexibility in diet and activity patterns of <i>Macaca tonkeana</i> in response to anthropogenic habitat alteration. <i>International Journal of Primatology</i> , 28(1), 107-133	"Dietary diversity is significantly lower in the Anca group, with 52% of their diet being palm fruits from <i>Arenga pinnata</i> ." [Fruits palatable to Sulawesi Tonkean macaques (<i>Macaca tonkeana</i>)]
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Young leaves, still white, are eaten in the same way as palm cabbage." [Refers to human consumption, but young leaves probably palatable to browsing/grazing animals as well, and older leaves probably unpalatable]
	WRA Specialist. (2020). Personal Communication	Palatability of foliage to browsing or grazing animals unknown

Qsn #	Question	Answer
405	Toxic to animals	
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Juice of the outer covering of fruit is highly corrosive and may cause pain and skin inflammation...Juice of ripe fruit is poisonous." [But animal toxicity unknown]
	Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18	"The fruits are dark red, about 2.5 cm in diameter, and are extremely irritating to the skin, containing calcium oxalate crystals." [But no other evidence of toxicity to animals or humans]
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"The green peel of the unripe fruit is poisonous and causes serious skin reactions on contact because of the calcium oxalate crystals; it is sometimes used to protect fish ponds from barefoot intruders. The pulped fruit in water brings fish to the surface. The seeds are favoured by pigs and used to bait wild pigs; many toys in the villages used to be carved from the seeds." [Unripe fruit may be toxic, but probably unlikely to be consumed by animals]

406	Host for recognized pests and pathogens	n
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"No serious diseases and pests occur. Consequently, crop protection chemicals are not normally used. On Java, a locust species (<i>Valanga nigricornis</i>) has been reported to attack leaves. Locally, caterpillars of <i>Artona catoxantha</i> , <i>Elymnias hypermnestanesaea</i> and <i>Hidar irava</i> have been observed eating young leaves. Top death of young plants has been reported and is possibly caused by flies of <i>Atherigona arenga</i> . Sometimes, caterpillars of <i>Batrachedra</i> spp. are observed on the male inflorescences. The top of young trees is occasionally damaged by the common coconut top borer (<i>Oryctes</i>). "
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"reported to tolerate disease, drought, fungus, high pH, insects, poor soil, shade, and slope...It is little subject to drought damage, typhoons, insect pests, or fungal diseases...Sugar palm is virtually insect-, pest- and disease-free, one fungus attacking the palm being <i>Ganoderma pseudoferreum</i> ."

Qsn #	Question	Answer
407	Causes allergies or is otherwise toxic to humans	y
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Juice of the outer covering of fruit is highly corrosive and may cause pain and skin inflammation Juice of ripe fruit is poisonous."
	Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18	"The fruits are dark red, about 2.5 cm in diameter, and are extremely irritating to the skin, containing calcium oxalate crystals."
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"The green peel of the unripe fruit is poisonous and causes serious skin reactions on contact because of the calcium oxalate crystals; it is sometimes used to protect fish ponds from barefoot intruders. The pulped fruit in water brings fish to the surface. The seeds are favoured by pigs and used to bait wild pigs; many toys in the villages used to be carved from the seeds."

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"It flourishes best in humid tropics in a rich moist soil, from sea-level to elevations of 1,200 m, being grown at higher elevations than coconut." [No evidence from native range that <i>A. pinnata</i> contributes to fire frequency or is adapted to fire prone regimens]

409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"reported to tolerate disease, drought, fungus, high pH, insects, poor soil, shade, and slope."
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"The seedlings stay alive in heavy shade but growth is minimal under such conditions." [Can establish in shaded conditions, but may not thrive until light levels increase, such as when a light gap occurs]

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Sugar palm grows best in warm conditions with a maximum amount of light and abundant water supply on very fertile soils. It can, however, grow under a wide variety of conditions, both in equatorial and seasonal climates, from sealevel up to 1400 m altitude, on all soil types from heavy loam to loamy sand and lateritic soils that are not regularly inundated."
	Palm Doctor. (2002). Palm of the Month! <i>Arenga pinnata</i> (Sugar Palm). September, 2002. http://www.palmdoctor.com . [Accessed 13 Mar 2020]	"Widely adaptable to many soil types"

411	Climbing or smothering growth habit	n
-----	--	----------

Qsn #	Question	Answer
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Tall, stout palm, 8 to 15 m tall, bole solitary, straight"

412	Forms dense thickets	y
	Source(s)	Notes
	Daehler, C. C. & Baker, R. F. 2006. New Records of Naturalized and Naturalizing Plants Around Lyon Arboretum, Mānoa Valley, O'ahu. Bishop Museum Occasional Papers 87: 3-18	"Naturalized plants around the Arboretum are probably in their third generation, and they form dense stands locally."
	Aman, S. S. (2018). Effects of selected alien plants on recruitment of three native tree species in Amani botanical garden, Tanzania MSc Thesis. Sokoine University of Agriculture, Morogoro, Tanzania	[No saplings recruit under stands of <i>Arenga pinnata</i> and other species] "Similarly, this study did not record any sapling species under <i>Phyllostachys bambusoides</i> , <i>Psidium cattleianum</i> and <i>Arenga pinnata</i> due to high shade and thickness that could not allow light to penetrate to support life for other species. Ultimately has resulted the whole area to have a mono dominant form of vegetation that affects the ecosystem services. Equally, Rajaonary et al. (2017) reported that invaded areas decreases diversity and abundance of native plants species."

501	Aquatic	n
	Source(s)	Notes
	Janick, J. & Paull, R.E. 2008. The Encyclopedia of Fruit and Nuts. CABI Publishing, Wallingford, UK	[Terrestrial] "It is a rainforest palm in its natural state, and thrives on rich, moist soil in partial shade, but is adaptable to drier areas and to full sun."
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	Terrestrial tree

502	Grass	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	Arecaceae
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 13 Mar 2020]	Family: Arecaceae (alt.Palmae) Subfamily: Coryphoideae Tribe: Caryoteae

Qsn #	Question	Answer
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	Arecaceae [not a nitrogen fixing woody plant]
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 13 Mar 2020]	Family: Arecaceae (alt.Palmae) Subfamily: Coryphoideae Tribe: Caryoteae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Tall, stout palm, 8 to 15 m tall, bole solitary, straight"

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Sugar palm is thought to be indigenous where it is encountered at present, except for the Pacific Islands and a few places in Africa where it has been introduced. This implies that its origin lies in an area covering SouthEast Asia up to Irian Jaya in the east, extending northeastwards to the Ryukyu Islands (Japan) and northwest to Annam (Vietnam) and the eastern Himalayas. It is mostly found near villages. It is found growing wild in primary or secondary forest."
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	No evidence

602	Produces viable seed	y
	Source(s)	Notes

Qsn #	Question	Answer
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Normally, people drop the seed where they would like the palm to grow. Sometimes wild seedlings are collected and transplanted. In a nursery, the following procedure has proved successful. Ripe, black fruits under superior palm trees are collected. Seed left behind after the fruit has decayed may also be collected. They are cleaned in water and those that float are removed. Seed with fungal or bacterial growth near the pore is also discarded. Then they are scratched on a rough stone to scarify the thin black outer layer down to the underlying brown layer, close to the pore. Filing down to the white endosperm may result in more seed rotting. The seed is left to soak in water or wet sacks for 24 hours. Then it is sown in coarse sand kept moist, with the gempore pointing downwards. Air humidity should be high during germination. After 3 weeks, some 75% have germinated; these are transferred to plastic containers when the germination tube is 2-3 cm long and before the upwardgrowing roots have formed, since these break off easily. A heavy-gauge polythene is used since flimsy material is easily perforated by the roots. Seed should be planted so deep that the germination tube does not dry out. The seedlings stay alive in heavy shade but growth is minimal under such conditions. Direct sunlight stimulates an early appearance of the first leaf. The seedlings can be planted out when the second leaf has unfurled. The young seedlings should be hardened off in the nursery before transplanting."
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"seeds 2 to 3 per fruit, dull-metallic, gray-brown, trigonous, oblong, 2.5 to 3.5 cm long, 2 to 2.5 cm wide, with copious endosperm"
	Janick, J.& Paull, R.E. 2008. The Encyclopedia of Fruit and Nuts. CABI Publishing, Wallingford, UK	"Sugar palm is propagated from seed, which germinates in 3–12 months."

603	Hybridizes naturally	y
	Source(s)	Notes
	Utami, N. 1986. Natural hybrid between <i>Arenga pinnata</i> and <i>A. obtusifolia</i> in Bogor Botanical Garden (Indonesia). <i>Berita Biologi</i> (Indonesia) 3: 296-299	"The morphology and leaf anatomy of three collections of <i>Arenga</i> sp. of uncertain identity, grown in the Bogor Botanical Gardens (Indonesia) are investigated and compared with those of <i>Arenga pinnata</i> and <i>Arenga obtusifolia</i> . Results showed that the characteristics of those collection oscillate between <i>A. pinnata</i> and <i>A. obtusifolia</i> . It is suggested consequently that the plants represent a natural hybrid of these two latter species."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"plants monoecious...female inflorescences usually preceding male"
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 13 Mar 2020]	"Reproductive Biology This monoecious palm first flowers when around 10-12 years old; however, sometimes it flowers as early as 5-6 years. Maturity is indicated by simultaneous appearance of 2 short leaves at the top of the stem. The average flowering period of an untapped tree is 4-6 years." [Self-compatibility unknown]

Qsn #	Question	Answer
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"The flowers are presumably cross-pollinated since there is little overlap in flowering of female and male inflorescences of the same palm."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Bees pollinate flowers, but small flies also swarm in large numbers around male inflorescences. "

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"A moderate to tall unbranched, hapaxanthic, solitary palm."
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 13 Mar 2020]	"A. pinnata can also be propagated through suckers." [But no evidence of vegetative spread]

607	Minimum generative time (years)	>3
	Source(s)	Notes
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 13 Mar 2020]	"Reproductive Biology This monoecious palm first flowers when around 10-12 years old; however, sometimes it flowers as early as 5-6 years. Maturity is indicated by simultaneous appearance of 2 short leaves at the top of the stem. The average flowering period of an untapped tree is 4-6 years."
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"The age of first flowering depends strongly upon the altitude, being 5-7 years at sea-level and 12 15 years at 900 m altitude."
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Trees reach reproductive maturity (flowering stage) in 6 to 12 years and continue to flower for about 15 years before replanting."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"seeds 2 to 3 per fruit, dull-metallic, gray-brown, trigonous, oblong, 2.5 to 3.5 cm long, 2 to 2.5 cm wide, with copious endosperm" [No evidence of unintentional dispersal, and fruits and seeds fairly large without means of external attachment]

702	Propagules dispersed intentionally by people	y
-----	--	---

Qsn #	Question	Answer
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"grown for its sugar, starch and fiber"
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	"Sugar palm is thought to be indigenous where it is encountered at present, except for the Pacific Islands and a few places in Africa where it has been introduced."

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"seeds 2 to 3 per fruit, dull-metallic, gray-brown, trigonous, oblong, 2.5 to 3.5 cm long, 2 to 2.5 cm wide, with copious endosperm" [Unlikely to contaminate produce due to relatively large seed size]

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"fruit obovoid to subglobose, smooth, 5 to 6 cm in diameter" [No adaptations for wind dispersal]

705	Propagules water dispersed	y
	Source(s)	Notes
	Quattrocchi, U. (2017). CRC World Dictionary of Palms: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"cultivated near villages or in towns, primary and secondary lowland forest, rain forest, usually near a river, weedy" [Proximity to rivers could facilitate secondary dispersal by water]
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"Trees are hardy, self-sustaining, growing readily in well-drained soil of dark cool valleys, along banks of mountain streams, along forest margins and on partially open hillsides." [Distribution along streams suggest fruit may be carried along water courses]

706	Propagules bird dispersed	y
	Source(s)	Notes
	Abdo, M. E. (2017). A Floristic Study of Halmahera, Indonesia Focusing on Palms (Arecaceae) and Their Seed Dispersal. PhD Dissertation. Florida International University, Miami, FL	"Among the other palms found to be dispersed by Papuan hornbills, <i>Arenga pinnata</i> and <i>Caryota rumphiana</i> are also known to be early-succession species. It is likely that hornbill seed deposition of these early colonizers has contributed to re-establishing plant growth into disturbed areas."
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"fruit obovoid to subglobose, smooth, 5 to 6 cm in diameter," [Large, fleshy-fruited, too large for most birds, but probably able to be secondarily dispersed on ground by birds or mammals]

Qsn #	Question	Answer
707	Propagules dispersed by other animals (externally)	
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"fruit obovoid to subglobose, smooth, 5 to 6 cm in diameter...In forests of Indo-Malaysia, ripe fruits are distributed by various fruit bats, civet cats, and wild swine." [Possible that fruit bats and other dispersers may transport fruits without ingesting seeds]

708	Propagules survive passage through the gut	Y
	Source(s)	Notes
	Duke, J.A. (2000). Handbook of Nuts. CRC Press, Boca Raton, FL	"fruit obovoid to subglobose, smooth, 5 to 6 cm in diameter...In forests of Indo-Malaysia, ripe fruits are distributed by various fruit bats, civet cats, and wild swine."
	Zona, S., & Henderson, A. 1989. A review of animal-mediated seed dispersal of palms. Selbyana 11: 6-21	"Table 1. Dispersal agents of palms." [A. pinnata - Dispersal agent (class) = (C) Paradoxurus hermaphroditus javanicus (M) Sus (M)"]
	van der Pijl, L. (1957). The dispersal of plants by bats (Chiropterochory). Acta Botanica Neerlandica, 6(3), 291-315	"TABLE 1. List of plants, described as being dispersed by bats" [Includes <i>Arenga pinnata</i>]
	Gunawan, R., Ramadhan, U. G., Iskandar, J., & Partasasmita, R. (2018). Local knowledge of utilization and management of sugar palm (<i>Arenga pinnata</i>) among Cipanggulaan People of Karyamukti, Cianjur (West Java, Indonesia). Biodiversitas Journal of Biological Diversity, 19 (1), 93-105	"The sugar palm trees in the mixed-garden or garden are not purposely planted by people, but they are predominantly dispersed by careuh or luwak (civet- <i>Paradoxurus hermaphroditus</i> Pallas 1777)."

801	Prolific seed production (>1000/m2)	
	Source(s)	Notes
	Flach, M. & Rumawas, F. (eds.). (1996). Plant resources of South-East Asia, No.9. Plants yielding non-seed carbohydrates. Backhuys Publishers, Leiden, The Netherlands	[Possibly Yes] "Each female inflorescence carries thousands of fruits which take 12 months from flowering to maturity if the palm is not tapped. One palm may produce as many as 250 000 seeds. "

802	Evidence that a persistent propagule bank is formed (>1 yr)	n
	Source(s)	Notes
	Tree Functional Attributes and Ecological Database. (2020). <i>Arenga pinnata</i> . http://db.worldagroforestry.org . [Accessed 13 Mar 2020]	"Germplasm Management Behaviour of seed in storage is recalcitrant; the seed is short-lived, and only 25% survive for 3 months in open storage." [No evidence of seed bank formation in field conditions]
	Junaedi, A., Wachjar, A., Yamamoto, Y., & Furqoni, H. (2020). Genotype characterization of sugar palm (<i>Arenga pinnata</i> (Wurmb.) Merr.) on seed and germination stage. IOP Conference Series: Earth and Environmental Science 418(1): 012041. doi:10.1088/1755-1315/418/1/012041	"Sugar palm seeds are classified into the recalcitrant seed group. One characteristic of recalcitrant seeds is that they have high water content [8]. Seed water content varies in the range of 22 36% (Table 4). High water content and high germination rate, except Bengkulu Lebong accession, were one of the recalcitrant seed characteristics [2]. This study supports the results of the study of [5] which stated that the decreased water content of the sugar palm seeds will also reduce the germination power."

Qsn #	Question	Answer
803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	Unknown. No information on herbicide efficacy or chemical control of this species

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	Unknown

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	Elbersen, H. W., & Oyen, L. P. A. (2010). Sugar palm (<i>Argena pinnata</i>). Potential of sugar palm for bio-ethanol production. FACT-Foundation	"Only rhinoceros beetles may affect the growing point of the palm, as they do in coconut and oil palm. The attack can lead to the death of the palm, but the scale of damage remains limited. Control is virtually impossible and would also disrupt the local ecology in a way that the net result would be negative." [Coconut rhinoceros beetles are adventive on Oahu, Hawaiian Islands. If they become established widely in the Hawaiian Islands, they could impact populations of this and other vulnerable palm taxa]

Summary of Risk Traits:

High Risk / Undesirable Traits

- Elevation range exceeds 1000 m, demonstrating environmental versatility
- Thrives in tropical climates
- Naturalized on Oahu and Hawaii (Hawaiian Islands), East Africa, Malaysia and possibly elsewhere
- Regarded as an environmental weed in Tanzania
- Old leaf bases covered with spines
- Outer covering of green, unripe fruit toxic and allergenic
- Shade tolerant
- Tolerates many soil types
- Capable of forming dense stands
- Reproduces by seeds
- May hybridize with other *Arenga* species
- Seeds dispersed by larger birds and frugivorous mammals, and intentionally by people
- One mature palm may produce as many as 250 000 seeds

Low Risk Traits

- Not reported to spread vegetatively
- May be predominantly outcrossing
- Reaches maturity from 5-7 years up to 12-15 years at higher elevations
- Relatively large seeds unlikely to be dispersed accidentally over long distances