

Taxon: *Theobroma grandiflorum* (Willd. ex Spreng.) K. Schum.

Family: Malvaceae

Common Name(s): Brazilian cocoa
copoasú
cupuaçú
cupuassú
large-flowered cocoa

Synonym(s): *Bubroma grandiflorum* Willd. ex
Guazuma grandiflora (Willd. ex
Theobroma grandiflora Willd. ex
Theobroma macrantha Bernoulli
Theobroma silvestre Spruce ex K.

Assessor: Chuck Chimera

Status: Assessor Approved

End Date: 9 Dec 2022

WRA Score: 0.0

Designation: L

Rating: Low Risk

Keywords: Tropical Tree, Edible Fruit, Shade-Tolerant, Self-Incompatible, Mammal-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	n
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		
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)	n
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		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		

Qsn #	Question	Answer Option	Answer
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	n
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	n
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		
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	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		
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	n
803	Well controlled by herbicides		
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)		

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Similar to other Amazonian crops, cupuassu might have been stimulated by native Amazonian people, resulting in a partial domestication (Clement 1999). Cupuassu is still one of the most common fruits found in agriculturist tribes of the eastern Amazon."
	Clement, C. R., de Cristo-Araújo, M., Coppens D'Eeckenbrugge, G., Alves Pereira, A., & Picanço-Rodrigues, D. (2010). Origin and domestication of native Amazonian crops. <i>Diversity</i> , 2(1), 72-106	[Presumably not heavily domesticated, but possibly modified during history of cultivation] "Another pattern is the relationship among crops with incipiently domesticated populations, or very recently domesticated populations, rapid pre- or post-Columbian dispersal and lack of phylogeographic population structure, e.g., Brazil nut, cupuassu and guaraná"

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	NA

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
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 5 Dec 2022]	"Native Southern America BRAZIL: Brazil [Acre (w.), Amazonas, Pará (s.)] Cultivated Southern America BRAZIL: Brazil (also cult.) WESTERN SOUTH AMERICA: Colombia [Caquetá], Ecuador, Peru [Loreto]"

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 5 Dec 2022]	

Qsn #	Question	Answer
203	Broad climate suitability (environmental versatility)	n
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"In its native habitat, the average temperatures range from 21 to 28°C. It will grow in places with average annual temperatures of 22–23°C. In Central America, it can be cultivated up to 600 m altitude (Vargas et al., 1999)."
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"It can be found at elevations between sea level and 1,000 m. Cupuassu prefers a very humid environment of 77–88% with little temperature variation throughout the year, and mean annual temperatures of between 21.6°C to 27.5°C, and rainfall of between 1,900 and 3,000 mm. Trees need lots of water for good growth. Prolonged dry periods are harmful to the tree causing flower shedding and premature fruit fall. Rains following a period of drought will also cause fruit cracking (Diniz et al. 1984)"
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"The species is well adapted to Koppen's climatic types Aw and Am, although it grows best under Af climatic regimes with rainfall above 1000 mm being essential and temperatures ranging from 21° to 30°C. In its natural range it does not appear above 400 m, however, there is no information available on its altitude limits although it is known to grow and fruit at 600 m in Turrialba, Costa Rica."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"Cupuassu is indigenous to the Amazon basin in the southern and eastern Pará, covering the areas of the middle Tapajós, Xingu and Guamá, and reaching the northeast of Maranhão in Brazil (Cuatrecasas 1964). It is widely cultivated in the north of Brazil, with the largest production in Pará, followed by Amazonas, Rondônia and Acre. It is also cultivated in Colombia, Venezuela, Ecuador, and Costa Rica."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"At present, it is cultivated in Brazil from São Paulo state in the south to Roraima state in the north; in many cases it is planted as a backyard plant since there are not many commercial-scale plantings. It is also being cultivated on a small scale in Trinidad and Tobago, Ecuador, Guyana, Colombia, Costa Rica, Venezuela, Colombia, Martinique and Ghana."
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"It is also cultivated in Colombia, Venezuela, Ecuador, and Costa Rica."

301	Naturalized beyond native range	
	Source(s)	Notes

Qsn #	Question	Answer
	Imada, C. (2019). Hawaiian Naturalized Vascular Plants Checklist (February 2019 update). Bishop Museum Technical Report 69. Bishop Museum, Honolulu, HI	No evidence
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

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

304	Environmental weed	n
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

305	Congeneric weed	n
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[<i>Theobroma cacao</i> included in some weed lists, but subsequent reviews of the literature cited did not corroborate any evidence of impacts] "References: Federated States of Micronesia-N-230, Puerto Rico-CW-261, Caribbean-N-707, Africa-W-760, United States of America-N-101, Costa Rica-CN- 872, Laos-N-1102, Gal pagos Islands-CN- 1157, Caribbean-N-1201, Brazil-N-1597, Global-CD-1611, Eastern Caribbean-N- 1742, Sao Tome and Principe-N-1805, Costa Rica-W-1977, Democratic Republic of the Congo-W-1977, Equatorial Guinea- W-1977, Lao People's Democratic Republic-W-1977."

401	Produces spines, thorns or burrs	n
	Source(s)	Notes

Qsn #	Question	Answer
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"An erect, evergreen, much-branched tree growing 5–15 m high with brown bark and tricomid branching (Plate 1). Leaves are simple, entire, alternate, coriaceous, narrowly ovate- to obovate-elliptic, 25–35 cm long and 6–10 cm wide, base rounded to shallowly cordate, apex long acuminate with a 9–10 pairs of lateral veins, bright-green, pubescent upper surface and grey underside (Plate 3). Young flushes are pink-bronze (Plate 2). Flowers bisexual, small, pentamerous, occurring in 3–5 flowered cymose inflorescence on trunk and main branches (Plates 3 and 4). Flower with a 5-lobed calyx divided nearly to base, 5 subtrapezoidal, purple petals, 5 stamens with bilocular anthers alternating with 5 staminodes and a pentagonal superior ovary with 5 locules containing numerous ovules. Fruit oblongish, obovate, subglobose to ellipsoidal, large, 20–25 cm long by 6–10 cm wide, weighing up to two kg, woody, hard, pubescent, rough, brown, fall to the ground when ripe (Plates 5 – 7)."

402	Allelopathic	
	Source(s)	Notes
	Ono Morikawa, C. I., Miyaoura, R., Tapia Y Figueroa, M. D. L., Rengifo Salgado, E. L., & Fujii, Y. (2012). Screening of 170 Peruvian plant species for allelopathic activity by using the Sandwich Method. Weed Biology and Management, 12(1): 1-11	[Possibly Yes] "Table 2. Allelopathic activity of the 176 samples (170 species) of Peruvian plants by the Sandwich Method" [<i>Theobroma grandiflorum</i> - stronger inhibitory activity in the radicle: * M – 1(s)]

403	Parasitic	n
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"This is a tree that can reach 18–20 m although in the wild it is found as a lower plant. Cultivated specimens are 6–10 m tall." [Malvaceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	Notes

Qsn #	Question	Answer
	e Silva, A. G. M., de Lima, S. C. G., de Oliveira, P. D., Moraes, M. D. S., Guimarães, C. M. C., da Silva, J. A. R., ... & Lourenço Júnior, J. D. B. (2021). Production, chemical composition, and fatty acid profile of milk from buffaloes fed with cupuaçu (<i>Theobroma grandiflorum</i>) cake and murumuru (<i>Astrocaryum murumuru</i>) cake in the Eastern Amazon. <i>Animal Science Journal</i> , 92(1), e13576	[Processed <i>Theobroma grandiflorum</i> is palatable] "The objective was to evaluate the effect of concentrate supplementation using by-products of the Amazonian industry on milk production, milk composition, and milk fatty acid profile of dairy buffaloes. Twelve lactating buffaloes (544.5 ± 35.6 kg, 6.4 ± 2.2 years old, 59 ± 6 days in milk) were allotted in a pasture of Mombaça grass and managed under rotational grazing (4 days occupancy/28 days rest). A 3 × 3 Latin square was adopted, and each animal alternately received three supplementary treatments based on corn bran + soybean meal or cupuaçu cake or murumuru cake for 21 days per treatment. Murumuru cake increased the levels of lauric acid and myristic acid in the milk (p < 0.05). Murumuru cake reduced the unsaturated fatty acid contents in the milk compared with animals fed control diet or cupuaçu cake (24.27% vs. 25.24% vs. 25.08%). The n-6/n-3 ratio was 2.6, 1.97, and 2.0 in the control, cupuaçu, and murumuru groups, respectively. Based on this parameter, cakes made from cupuaçu as well as murumuru could be considered to be adequate for inclusion in dairy water buffalo feed. However, the murumuru cake addition requires some caution because its use induces the secretion of higher levels of lauric and myristic fatty acids that are related to human cardiovascular disease."
	Walkden-Brown, S. W., & Banks, D. J. D. (1986). Integrated small ruminant and cropping systems in Fiji with health as a major constraint. Pp. 289-310 In <i>Small Ruminant Production Systems in South and Southeast Asia: Proceedings of a workshop held in Bogor, Indonesia, 6-10 Oct. 1986</i> . IDRC, Ottawa, Canada	[<i>Theobroma grandiflorum</i> possibly similarly palatable] "The 3550 ha of cocoa plantations in Fiji are not integrated with livestock at all because of the palatability of cocoa leaves and bark. There is no utilization of cocoa pods for livestock feed because of the small-scale nature of the industry at present and the problems of drying pods in the high-rainfall cocoa areas."

405	Toxic to animals	n
	Source(s)	Notes
	Growables. (2022). Cupuassu - <i>Theobroma grandiflorum</i> . https://www.growables.org/information/TropicalFruit/Cupuassu.htm . [Accessed 9 Dec 2022]	"Known hazard - None known"

Qsn #	Question	Answer
	e Silva, A. G. M., de Lima, S. C. G., de Oliveira, P. D., Moraes, M. D. S., Guimarães, C. M. C., da Silva, J. A. R., ... & Lourenço Júnior, J. D. B. (2021). Production, chemical composition, and fatty acid profile of milk from buffaloes fed with cupuaçu (<i>Theobroma grandiflorum</i>) cake and murumuru (<i>Astrocaryum murumuru</i>) cake in the Eastern Amazon. <i>Animal Science Journal</i> , 92(1), e13576	[No evidence. Processed <i>Theobroma grandiflorum</i> is palatable] "The objective was to evaluate the effect of concentrate supplementation using by-products of the Amazonian industry on milk production, milk composition, and milk fatty acid profile of dairy buffaloes. Twelve lactating buffaloes (544.5 ± 35.6 kg, 6.4 ± 2.2 years old, 59 ± 6 days in milk) were allotted in a pasture of Mombaça grass and managed under rotational grazing (4 days occupancy/28 days rest). A 3 × 3 Latin square was adopted, and each animal alternately received three supplementary treatments based on corn bran + soybean meal or cupuaçu cake or murumuru cake for 21 days per treatment. Murumuru cake increased the levels of lauric acid and myristic acid in the milk (p < 0.05). Murumuru cake reduced the unsaturated fatty acid contents in the milk compared with animals fed control diet or cupuaçu cake (24.27% vs. 25.24% vs. 25.08%). The n-6/n-3 ratio was 2.6, 1.97, and 2.0 in the control, cupuaçu, and murumuru groups, respectively. Based on this parameter, cakes made from cupuaçu as well as murumuru could be considered to be adequate for inclusion in dairy water buffalo feed. However, the murumuru cake addition requires some caution because its use induces the secretion of higher levels of lauric and myristic fatty acids that are related to human cardiovascular disease."
	Quattrocchi, U. (2012). <i>CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology</i> . CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). <i>Exotic fruits and nuts of the New World</i> . CABI, Wallingford, UK	"“Witches’ broom” (<i>Crinipellis perniciosa</i>) is one of the most serious and common diseases. The disease damages the branches by causing swelling and abnormal growth and excessive sprouting of the affected area resulting in bending, drying and breaking of the branches. It can also attack the fruit and flowers. Infected fruit and branches should be removed; in the case of branches, they should be cut well below the diseased part and this should be done soon after the peak of the rainy season. As the rainy season ends copper fungicides should be sprayed. Anthracnose (<i>Colletotrichum gloeosporioides</i>) attacks leaves, flowers and fruit producing black spots. <i>Phomopsis</i> fungus causes rust-colored necrotic spots in the leaves; it can also attack the fruits and branches. <i>Lasiodiplodia theobromae</i> causes internal rot in fruit it enters through wounds made by insects. <i>Pellicularia koleroga</i> can also cause damage. insects Leaf cutting ants (<i>Atta</i>) can be a problem with young plants. Crickets (<i>Grillus</i>) can also damage young plants. Aphids, mainly <i>Toxoptera citricidus</i> , can attack young growth. Chrysomelidae can also be a problem as well as some caterpillars and <i>Trigona</i> bees in certain cases. The fruit borer <i>Conotrachelus humeropticus</i> enters the fruit and causes internal rots; it is one of the worst insect problems. Rodents like to eat freshly sown seeds in the seedbed (Andersen and Ulup-Andersen, 1988; Villachica et al., 1996)."

Qsn #	Question	Answer
407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Growables. (2022). Cupuassu - Theobroma grandiflorum. https://www.growables.org/information/TropicalFruit/Cupuassu.htm . [Accessed 9 Dec 2022]	"Known hazard - None known"
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	[No evidence] "The juicy and sweet-acid pulp surrounding the seeds is used for many purposes in addition to as a fresh fruit (Table 9.3). The pulp can be made into a juice in a blender and this is gaining popularity in foreign markets. Other uses of the pulp are to make canned juices, sherbets, compotes, jellies, ice cream, yogurt, liquor and wine. Yields from 10 kg fruit are around 4.6 kg pulp, 3.8 kg peel and 1.6 kg seeds. There are seedless fruit that yield 67% of pulp in weight (Andersen and Ulup-Andersen, 1988)." ... "The seeds contain 50–60% fat that is very digestible, similar to cacao, but does not contain caffeine, only theobromine. The seeds have 20% protein and 16% carbohydrates and 9.6% fiber (Table 9.3). The seeds can be used to make a chocolate-like product called in Brazil “cupulate” that has very good flavor (Donadio et al., 2002) and the fat can substitute for cacao butter; 1 kg seed produces 0.25 kg of “cupulate”."
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence
408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	[No evidence. Occurs at relatively low densities in areas not prone to frequent fires] "Theobroma grandiflorum occurs in the low, open forests of eastern Amazonia in densities of up to 14 trees hectare, preferring rich, sandy clays and loam soils with good drainage, although it will withstand short periods of flooding. The tree grows best in semi-shade but withstands full sun when growing on good soils; it does not easily escape into areas of heavily shaded forest."
409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"It will tolerate some shade, since it can be found growing under the canopy of tall trees. The young plants will need shade during their first year in the field and when adult they can grow under shade or in full sun."
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"The tree grows best in semi-shade but withstands full sun when growing on good soils; it does not easily escape into areas of heavily shaded forest."
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	n

Qsn #	Question	Answer
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"The plant prefers a well-drained deep fertile soil with no flooding periods. In poorer soils, it will need judicious fertilization (Andersen and Ulup-Andersen, 1988)."
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"Theobroma grandiflorum occurs in the low, open forests of eastern Amazonia in densities of up to 14 trees hectare, preferring rich, sandy clays and loam soils with good drainage, although it will withstand short periods of flooding."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"This is a tree that can reach 18–20 m although in the wild it is found as a lower plant."

412	Forms dense thickets	n
	Source(s)	Notes
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"Theobroma grandiflorum occurs in the low, open forests of eastern Amazonia in densities of up to 14 trees hectare, preferring rich, sandy clays and loam soils with good drainage, although it will withstand short periods of flooding."

501	Aquatic	n
	Source(s)	Notes
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	[Terrestrial] "The cupuassu tree can be found throughout the Amazon region as part of spontaneous vegetations on non-inundated areas, particularly near existing or former settlements, in high-rainfall primary forests and along river banks."

502	Grass	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 5 Dec 2022]	"Family: Malvaceae Subfamily: Byttnerioideae Tribe: Theobromateae"

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 5 Dec 2022]	"Family: Malvaceae Subfamily: Byttnerioideae Tribe: Theobromateae"

Qsn #	Question	Answer
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"An erect, evergreen, much-branched tree growing 5–15 m high with brown bark and tricomis branching"

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"Cupuassu is indigenous to the Amazon basin in the southern and eastern Pará, covering the areas of the middle Tapajós, Xingu and Guamá, and reaching the northeast of Maranhão in Brazil (Cuatrecasas 1964) . It is widely cultivated in the north of Brazil, with the largest production in Pará, followed by Amazonas, Rondônia and Acre. It is also cultivated in Colombia, Venezuela, Ecuador, and Costa Rica."
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Similar to other Amazonian crops, cupuassu might have been stimulated by native Amazonian people, resulting in a partial domestication (Clement 1999). Cupuassu is still one of the most common fruits found in agriculturist tribes of the eastern Amazon."

602	Produces viable seed	y
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"Propagation: sexual. This was the usual propagation method; now it is recommended to obtain rootstocks. The best quality seeds come from large fruit from healthy plants and only the largest seeds of each fruit should be selected to get better quality plants. Seeds should be fermented for 12–24 h to get rid of the pulp or the pulp can be removed manually using shears, then by rubbing the seeds with sand and rinsing them thoroughly to get rid of the pulp residues. Sowing should not be delayed more than a couple of days to avoid dehydration. Clean seeds are sown in trays or seedbeds under 50% shade or pre-germinated in moist sand or sawdust and as soon as the radicle emerges put in a nursery bag and buried 1 cm deep with the radicle pointing down. In the seedbed or trays, germination will start in 2 weeks and will be finished in about 3–4 weeks when 90% of seeds have germinated. The seedlings should be transplanted into nursery bags and transferred under 25% shade when they are about 15 cm. The use of trays with cells makes the process much more efficient and eliminates transplant shock. Germination is hypogeal (Donadio et al., 2002)."
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"Seed propagation has been the norm in cupuaçu propagation. Like the cocoa (<i>T. cacao</i> L.) the viability of the cupuaçu seed is extremely limited, ranging from 2 to 3 days with no care to about 2 weeks with elaborate precautions. The seed are germinated in seed-beds at a depth of 1 to 2 cm with daily watering to maintain high humidity. Germination takes 10 to 20 days and initial growth is rapid and will continue to be if soil fertility is maintained."

Qsn #	Question	Answer
603	Hybridizes naturally	
	Source(s)	Notes
	Zhang, D., Figueira, A., Motilal, L., Lachenaud, P., & Meinhardt, L. W. (2011). <i>Theobroma</i> . Pp. 277-296 In <i>Wild Crop Relatives: Genomic and Breeding Resources</i> . Springer, Berlin, Heidelberg	"Although, natural hybrids between the species of <i>Theobroma</i> are rare, there are reports of occurrence, mainly between species of the <i>Glossopetalum</i> section (Silva et al. 2004) ... "Successful interspecific crosses involving <i>T. cacao</i> have been obtained according to reports (Silva et al. 2004), as hybrid pods between <i>T. cacao</i> x <i>T. mammosum</i> , <i>T. cacao</i> x <i>T. simiarum</i> and <i>T. cacao</i> x <i>T. speciosum</i> ; as hybrid seedlings from <i>T. cacao</i> x <i>T. microcarpum</i> and <i>T. cacao</i> x <i>T. angustifolium</i> ; and adult hybrid plants from <i>T. cacao</i> x <i>T. grandiflorum</i> (Martinson 1966)."
	Lim, T.K. (2012). <i>Edible Medicinal and Non-Medicinal Plants</i> . Volume 3, Fruits. Springer, New York	"Artificial hybrids between <i>T. grandiflorum</i> and <i>T. obovatum</i> produce fruits with the characteristics of cupuaçu, but which are smaller and less resistant to witches' broom disease."
	Cuatrecasas, J. (1964). <i>Cacao and its Allies a Taxonomic Revision of the Genus Theobroma</i> . Contributions from the United States National Herbarium, 35(6), 1-614	"Better results were attained by Addison and Miranda in crossing <i>T. grandiflorum</i> and <i>T. obovatum</i> ; many hybrid seedlings were produced and several developed into perfect trees (in 1½ years); the leaves, fruits, and flowers of the hybrids showed intermediate characters, and the pollen grains were normal and fertile. Well-developed hybrids between <i>T. grandiflorum</i> and <i>T. subincanum</i> , <i>T. obovatum</i> and <i>subincanum</i> , and <i>T. speciosum</i> and <i>T. sylvestre</i> (= <i>spruceanum</i>) were also produced. In 1948, some fruits were obtained by crossing <i>T. cacao</i> with <i>T. grandiflorum</i> , but these gave very few seeds, from which only few plants developed up to 15 cm."

604	Self-compatible or apomictic	n
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Cupuassu is considered an outbreeding species because of its floral morphology, adapted to pollination by insects, and the occurrence of a complex self-incompatibility system (Alves et al. 1997), probably similar to <i>T. cacao</i> (Cope 1976)."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). <i>Exotic fruits and nuts of the New World</i> . CABI, Wallingford, UK	"Several species of bees pollinate the flowers but they are not abundant and thus the percentage of natural pollination is 2%, which results in many farmers doing artificial pollination. The flowers open around noon time and in the afternoon and stigmas remain receptive until next morning when artificial pollination can be done (Donadio et al., 2002)."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes

Qsn #	Question	Answer
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	[No evidence of natural vegetative spread] "Asexual. This is the recommended method to propagate plants with desirable characteristics such as fruit size, yield, pulp-to-fruit ratio, plant size and seedlessness. At present grafting or budding is used when the rootstock attains 1 cm diameter at 20–30 cm from the ground. Shield or patch budding and side, cleft or splice graft can be used, and scions have to be in a semi hardwood condition (Andersen and Ulup-Andersen, 1988). The branch from where the buds will be taken has to be defoliated and topped about 2 weeks before harvesting the buds to promote the swelling of them. In the case of grafting, upright growing branches of the mother plant tipped with mature leaves are used as scions; after cutting the scions, the upper two leaves should be reduced to 5 cm of petiole and the rest of the leaves removed, while the rootstock should be left with as many leaves as possible. The grafted plants are kept under at least 50% shade. The new growth will tend to be plagiotropic therefore orienting the branches by tying them to stakes is needed (Villachica et al., 1996)."

607	Minimum generative time (years)	3
	Source(s)	Notes
	CGIAR Research Program - Forests, Trees and Agroforestry (2022). <i>Theobroma grandiflorum</i> Copoazu. https://www.foreststreesagroforestry.org/tree/theobroma-grandiflorum/ . [Accessed 5 Dec 2022]	"Maturity of tree before yields - 3 years"
	Chaves, S. F., Dias, L. A., Alves, R. S., Alves, R. M., Evangelista, J. S., & Dias, K. O. (2022). Leveraging multi-harvest data for increasing genetic gains per unit of time for fruit yield and resistance to witches' broom in <i>Theobroma grandiflorum</i> . <i>Euphytica</i> , 218(12), 1-12	" <i>Theobroma grandiflorum</i> has a long juvenile period (about 3 years) and it takes about 8 years for it to reach full production maturity."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans. Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Duarte, O., & Paull, R. (2015). Exotic fruits and nuts of the New World. CABI, Wallingford, UK	"At present, it is cultivated in Brazil from São Paulo state in the south to Roraima state in the north; in many cases it is planted as a backyard plant since there are not many commercial-scale plantings. It is also being cultivated on a small scale in Trinidad and Tobago, Ecuador, Guyana, Colombia, Costa Rica, Venezuela, Colombia, Martinique and Ghana."

Qsn #	Question	Answer
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"It is widely cultivated in the north of Brazil, with the largest production in Pará, followed by Amazonas, Rondônia and Acre. It is also cultivated in Colombia, Venezuela, Ecuador, and Costa Rica."

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	Notes
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"Seed, subglobose, 2 cm across, covered in white testa, cotyledons fleshy, nonendospermous." [No evidence, andn unlikely. Fruits and seeds large and recalcitrant]
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans. Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees."
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	"Fruit oblongish, obovate, subglobose to ellipsoidal, large, 20–25 cm long by 6–10 cm wide, weighing up to two kg, woody, hard, pubescent, rough, brown, fall to the ground when ripe (Plates 5–7). The endocarp is yellowish-white, pulpy, soft, aromatic, and acid-sweet enclosing 25–50 superposed seeds in five rows (Plate 8). Seed, subglobose, 2 cm across, covered in white testa, cotyledons fleshy, non=endospermous."

705	Propagules water dispersed	n
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees." [Buoyancy unknown]
	Lim, T.K. (2012). Edible Medicinal and Non-Medicinal Plants. Volume 3, Fruits. Springer, New York	[Possible that fruits in riparian areas may be moved by water] "The cupuassu tree can be found throughout the Amazon region as part of spontaneous vegetations on non-inundated areas, particularly near existing or former settlements, in high-rainfall primary forests and along river banks."

Qsn #	Question	Answer
706	Propagules bird dispersed	
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	[No evidence, although dispersal by game birds in Hawaii may be possible] "Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans. Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees."

707	Propagules dispersed by other animals (externally)	y
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	[Large fruit and seeds presumably carried by rodents and perhaps other animals] "Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans. Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees."

708	Propagules survive passage through the gut	y
	Source(s)	Notes
	Clement, C. R., de Cristo-Araújo, M., Coppens D'Eeckenbrugge, G., Alves Pereira, A., & Picanço-Rodrigues, D. (2010). Origin and domestication of native Amazonian crops. <i>Diversity</i> , 2(1), 72-106	"cupuassu may have been dispersed by now-extinct Pleistocene megafauna [141], whose larger size may have permitted greater dispersal distances." [Presumably adapted for vertebrate dispersal. Seeds presumed to survive gut passage if ingested by larger dispersers, or seeds may be processed without ingestion]
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans. Fruit drop from tall trees (often >30 m) may facilitate self-dispersion, but usually, seedlings are not found around mature trees."

801	Prolific seed production (>1000/m²)	n
	Source(s)	Notes
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"Fruit oblong-- to obovoid-ellipsoid 15-40 cm long, 10-15 cm in diameter, rounded at both ends, smooth, thinly brown-tomentose, falling at maturity; pericarp hard, c. 1 cm thick, mesocarp 5-7 mm thick, fleshy at maturity with a thin membrane surrounding the seed cavity; seeds 20-60, arranged in 5 rows" ... "A young mature tree may produce as many as 40 fruit/year, although this can increase significantly with fertilization." [One tree can produce about 800-2400 seeds per tree per year, but seeds unlikely to reach densities of >1000 m ⁻²]

802	Evidence that a persistent propagule bank is formed (>1 yr)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Alves, R. M., Sebbenn, A. M., Artero, A. S., Clement, C., & Figueira, A. (2007). High levels of genetic divergence and inbreeding in populations of cupuassu (<i>Theobroma grandiflorum</i>). <i>Tree Genetics & Genomes</i> , 3(4), 289-298	"Cupuassu seeds are recalcitrant (Velho et al. 1990), and seed dispersion is thought to be performed by large rodents (such as agouti) and primates, including humans."
	FAO. (1986). Food and fruit-bearing forest species 3: Examples from Latin America. FAO Forestry Paper, 44(3). Food & Agriculture Organization of the United Nations, Rome	"Seed propagation has been the norm in cupuaçu propagation. Like the cocoa (<i>T. cacao</i> L.) the viability of the cupuaçu seed is extremely limited, ranging from 2 to 3 days with no care to about 2 weeks with elaborate precautions."

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	Unknown. No information on herbicide efficacy or chemical control of this species

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	Notes
	Growables. (2022). Cupuassu - <i>Theobroma grandiflorum</i> . https://www.growables.org/information/TropicalFruit/Cupuassu.htm . [Accessed 9 Dec 2022]	"When this tree of the humid tropics becomes too large, it can survive severe pruning, which the closely-related cocoa would not tolerate."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	Matsunaga, J. N. & Chun, S. G. (2018). <i>Acalolepta aesthetica</i> (Olliff), a longhornedbeetle (Coleoptera: Cerambycidae). New Pest Advisory No. 18-02. Plant Pest Control Branch, Hawaii Department of Agriculture, Honolulu. https://hdoa.hawaii.gov . [Accessed]	[Unknown whether or not <i>A. aesthetica</i> will act as a limiting factor on <i>Theobroma</i> species in the Hawaiian Islands] "Adult feeding habits remain unknown although they likely feed on leaves, petioles or bark of plants, without causing significant damage. Damage to trees is caused by the larvae which feed and tunnel within the woody portion of the host, compromising the structural integrity of the branches and trunk. Larval feeding creates entry points for pathogens, making the host plant more susceptible to secondary disease infections and attack by additional wood boring pests, further compromising host plant health. Heavy infestation of already weakened trees may lead to plant death. Because cerambycid larvae are wood borers which feed within dead or dying trees, infestation of by other species of longhorn beetles may be mistakenly attributed to <i>A. aesthetica</i> ." "Hosts confirmed in Hawaii thus far include breadfruit (<i>Artocarpus altilis</i>), kukui (<i>Aleurites moluccanus</i>), queen sago (<i>Cycas circinalis</i>), Citrus spp., and cacao (<i>Theobroma cacao</i>)."

Summary of Risk Traits:

High Risk / Undesirable Traits

- Thrives, and could potentially spread, in regions with tropical climates
- Potential allelopathic properties
- Shade tolerant
- Reproduces by seeds (facilitating possible naturalization)
- Reaches reproductive maturity in 3 years
- Seeds dispersed by gravity, frugivorous mammals and through intentional cultivation
- Tolerates sever pruning

Low Risk Traits

- Despite widespread cultivation, no confirmed reports of naturalization or invasiveness outside native range
- Unarmed (no spines, thorns, or burrs)
- Heavy shade may inhibit spread
- Largely self-incompatible
- Although bee-pollinated, pollinator limitations may reduce seed set
- Not reported to spread vegetatively
- Large fruit and seeds relatively large and unlikely to be accidentally dispersed
- Seeds recalcitrant and unlikely to form a persistent seed bank