

<b>Taxon:</b> <i>Elettaria cardamomum</i> (L.) Maton	<b>Family:</b> Zingiberaceae
<b>Common Name(s):</b> cardamom green cardamom true cardamom	<b>Synonym(s):</b> <i>Alpinia cardamomum</i> (L.) Roxb. <i>Amomum cardamomum</i> L. <i>Cardamomum malabaricum</i> Pritz. <i>Cardamomum officinale</i> Salisb. <i>Matonia cardamomum</i> (L.) <i>Zingiber minus</i> Gaertn.

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 12 Feb 2019
<b>WRA Score:</b> 3.0	<b>Designation:</b> L	<b>Rating:</b> Low Risk

**Keywords:** Rhizomatous Herb, Naturalized, Spice-Plant, Shade Tolerant, Spreads Vegetatively

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	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		
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	n
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals		
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)		
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	y=1, n=-1	n
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
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)		
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)		
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		
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
	van Wyk, B.-E. 2014. Culinary Herbs and Spices of the World. University of Chicago Press, Chicago, IL	"Cultivated cardamom does not differ from the wild type."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2019). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2019). 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, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 7 Feb 2019]	"Native Asia-Tropical INDIAN SUBCONTINENT: India, [Kerala] Sri Lanka"

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 7 Feb 2019]	

203	Broad climate suitability (environmental versatility)	n
	Source(s)	Notes
	KewScience. (2019). Plants of the World Online - <i>Elettaria cardamomum</i> . <a href="http://powo.science.kew.org">http://powo.science.kew.org</a> . [Accessed 8 Feb 2019]	"A low-growing, leafy tropical plant that grows on the forest floor in the wild: cardamom must be grown indoors in temperate regions." ... "Hardiness: Cardamom will not survive outdoors in temperate regions, even in summer. It requires a heated greenhouse or a warm, shady humid place inside a building - hot steamy bathrooms are ideal. The minimum temperature is 22°C, but it will tolerate places a little colder for a short time if kept dry at the roots."

Qsn #	Question	Answer
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Cardamom grows wild in the shade in the forests of southern India as it does not tolerate direct sun. It thrives best in areas with uniform warm temperature 24–30°C and mean annual rainfall of 1,500 mm well distributed through out the year, on well-drained, soil rich in organic matter. Shade is important during the hot summer season and during the rainy season shade is thinned. Cardamoms are traditionally cultivated under shade trees. Tall trees having well spaced branching habit and small leaves are ideal shade trees for cardamom."
	van Wyk, B.-E. 2014. Culinary Herbs and Spices of the World. University of Chicago Press, Chicago, IL	"They require a tropical climate and thrive at higher latitudes in the shade of forest trees."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Cardamom is one of the world's very ancient spices. It is native to the India and Sri Lanka originating in the forests of the western Ghats in southern India, where it grows wild (Plate 1 ). Today it cultivated in India, Nepal, Sri Lanka, Guatemala, Mexico, Tanzania, Vietnam and Thailand. The major producing areas for cardamom in India are Sikkim and Kerala."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Cardamom reached Hawai'i by 1885 (or earlier), when six plants arrived from Jamaica. It is cultivated here only by ginger fanciers and herb and spice enthusiasts."
	van Wyk, B.-E. 2014. Culinary Herbs and Spices of the World. University of Chicago Press, Chicago, IL	"In the modern era it has become an important crop, with Guatemala as the main producer (5 000 tons per annum), followed by India (4 000 tons). Minor producers include Tanzania, Sri Lanka and Papua New Guinea. "
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Today it cultivated in India, Nepal, Sri Lanka, Guatemala, Mexico, Tanzania, Vietnam and Thailand. The major producing areas for cardamom in India are Sikkim and Kerala."

301	Naturalized beyond native range	y
	Source(s)	Notes
	Global Invasive Species Database. (2019). Species profile: <i>Elettaria cardamomum</i> . <a href="http://www.iucngisd.org/gisd/species.php?sc=1299">http://www.iucngisd.org/gisd/species.php?sc=1299</a> on 09-02-2019. [Accessed 8 Feb 2019]	" <i>Elettaria cardamomum</i> is a herbaceous rhizome from India valued as an aromatic. The species is naturalised in La Réunion where it is spreading in natural or semi-natural ecosystems with a relatively high density." [Potential to become an environmental weed. Impacts unspecified at present]
	Sheil, D. (1994). Naturalized and invasive plant species in the evergreen forests of the East Usambara Mountains, Tanzania. <i>African Journal of Ecology</i> , 32(1), 66-71	"Table 1. An annotated list of naturalized plants found in the evergreen forests of the East Usambara Mountains." ... " <i>Elettaria cardamomum</i> ... Cardamon. Spice widely planted under degraded forest cover. Considered naturalized in derelict sites. Known as a forest invasive in Sri Lanka. (As)"

Qsn #	Question	Answer
	Kueffer, C. & Vos, P. 2004. Case Studies on the Status of invasive Woody Plant Species in the Western Indian Ocean: 5. Seychelles. Forest Health & Biosecurity Working Papers FBS/4-5E. FAO Forestry Dept., Rome, Italy	[ <i>Elettaria cardamomum</i> listed among problematic herbaceous plants. Potential environmental weed. Impacts unspecified] "Although the scope of this study did not include herbaceous species, it is important to mention them briefly as they are also of major concern in Seychelles. Creepers, in particular, should be given careful consideration as they seem to escape their usual habitat (degraded land around towns and along roads) to establish in forests and key areas for biodiversity. Their further spread could be a serious problem if not appropriately controlled. It is worth noting that concern over creepers is recent, as the last forestry sector study (INDUFOR 1993) did not mention them. Their spread is undoubtedly rapid. The main problematic non-woody plant species mentioned during this study were:" ... "Other herbaceous plants: <i>Agave sisalana</i> , <i>Alocasia macrorrhiza</i> , <i>Ananas comosus</i> , <i>Caladium</i> sp., <i>Clerodendrum</i> sp., <i>Desmodium canum</i> , <i>Dieffenbachia seguine</i> , <i>Elettaria cardamomum</i> <i>Furcraea foetida</i> , <i>Stachytarpheta jamaicensis</i> and <i>Stachytarpheta urticaefolia</i> "
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. (2019). Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. <a href="http://botany.si.edu/">http://botany.si.edu/</a> . [Accessed 12 Feb 2019]	No evidence in Hawaiian Islands to date

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
	Global Invasive Species Database. (2019). Species profile: <i>Elettaria cardamomum</i> . <a href="http://www.iucngisd.org/gisd/species.php?sc=1299">http://www.iucngisd.org/gisd/species.php?sc=1299</a> on 09-02-2019. [Accessed 8 Feb 2019]	" <i>Elettaria cardamomum</i> is a herbaceous rhizome from India valued as an aromatic. The species is naturalised in La aRéunion where it is spreading in natural or semi-natural ecosystems with a relatively high density." [Potential to become an environmental weed. Impacts unspecified at present]

Qsn #	Question	Answer
	Kueffer, C. & Vos, P. 2004. Case Studies on the Status of invasive Woody Plant Species in the Western Indian Ocean: 5. Seychelles. Forest Health & Biosecurity Working Papers FBS/4-5E. FAO Forestry Dept., Rome, Italy	[ <i>Elettaria cardamomum</i> listed among problematic herbaceous plants. Potential environmental weed. Impacts unspecified] "Although the scope of this study did not include herbaceous species, it is important to mention them briefly as they are also of major concern in Seychelles. Creepers, in particular, should be given careful consideration as they seem to escape their usual habitat (degraded land around towns and along roads) to establish in forests and key areas for biodiversity. Their further spread could be a serious problem if not appropriately controlled. It is worth noting that concern over creepers is recent, as the last forestry sector study (INDUFOR 1993) did not mention them. Their spread is undoubtedly rapid. The main problematic non-woody plant species mentioned during this study were:" ... "Other herbaceous plants: <i>Agave sisalana</i> , <i>Alocasia macrorrhiza</i> , <i>Ananas comosus</i> , <i>Caladium</i> sp., <i>Clerodendrum</i> sp., <i>Desmodium canum</i> , <i>Dieffenbachia seguine</i> , <i>Elettaria cardamomum</i> <i>Furcraea foetida</i> , <i>Stachytarpheta jamaicensis</i> and <i>Stachytarpheta urticaefolia</i> "

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

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[No evidence] "A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots. Leaves distichous, petioles up to 2.5 cm long; lamina up to c. 1 m × 15 cm, lanceolate, acuminate, lightly pubescent or glabrous below; ligule to 1 cm long, entire"

402	Allelopathic	n
	Source(s)	Notes
	Fujii, Y., Parvez, S. S., Parvez, M., Ohmae, Y., & Iida, O. 2003. Screening of 239 medicinal plant species for allelopathic activity using the sandwich method. <i>Weed Biology and Management</i> , 3(4): 233-241	"Table 1. Screening of leaf litter of 239 medicinal plant species under different families using the sandwich method" [ <i>Elettaria cardamomum</i> was not shown to possess stronger inhibitory activity greater than the mean]

403	Parasitic	n
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots." [Zingiberaceae. No evidence]

Qsn #	Question	Answer
404	<b>Unpalatable to grazing animals</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). Plant resources of South-East Asia, No.13. Spices. Backhuys Publishers, Leiden, The Netherlands	"Damage is frequently caused by rats, monkeys, porcupines, wild pigs and birds." [Fruit capsules may be vulnerable to damage. Palatability of foliage unspecified]
	Chakravarthy, A. K. (1993). Vertebrate Pest Management on Cardamom ( <i>Elettaria cardamomum</i> Maton) and other crops in Malnad region. University of Agricultural Sciences, Bangalore	[Shoots fed on by monkeys in India. Possible that other animals could find plants palatable] "Field observations revealed that monkey preferred to feed on tender (less than 3 years old) pseudostems of cardamom in the absence of wild fruits like guava, jackfruit, chakota, oranges, banana and paddy. At times of no or negligible human activity, monkeys were found entering the cropped area one by one. The animals held the base of the pseudostems with one hand and with teeth, peeled out the outersheaths; cut open the yellowish white pith and fed on it. The animals usually fed on 10% of the shoot biomass they destroyed. Monkey was the only pest feeding on cardamom shoot."

405	Toxic to animals	
	<b>Source(s)</b>	<b>Notes</b>
	KewScience. (2019). Plants of the World Online - <i>Elettaria cardamomum</i> . <a href="http://powo.science.kew.org">http://powo.science.kew.org</a> . [Accessed 8 Feb 2019]	"No toxicity has been reported for cardamom, but care needs to be taken that the plant being used is cardamom and not a substitute. " ... "Hazards - None known."
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[Possibly at high doses to some animals] "Toxicity studies showed that <i>E. cardamomum</i> induced toxicity at 0.3 mg/g mouse and affected energy metabolism and oxidative stress (Malti et al. 2007) . A significant increase in creatine phosphokinase level was observed. The microscopic evaluation showed that <i>E. cardamomum</i> induce morphological perturbation in mice's heart. The results showed also an inhibitory effect of glyceraldehyde 3-phosphate dehydrogenase and an important increase in the level of thiobarbituric acid reactive substances, succinate dehydrogenase and catalase activities."

406	Host for recognized pests and pathogens	
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). Plant resources of South-East Asia, No.13. Spices. Backhuys Publishers, Leiden, The Netherlands	"The most important disease of cardamom in southern India is the mosaic virus known as katte or marble disease, transmitted by the banana aphid <i>Pentalonia nigronervosa</i> . Planting of diseased rhizomes is a serious source of infection. The only control measures appear to be the careful roguing of affected plants and the planting of non-affected seedlings. A nursery leaf rot, caused by <i>Coniothyrium</i> sp. or <i>Phyllosticta</i> sp., results in spotting and eventual rotting of the leaves in the nursery. The disease is worst in the wet season, but it may be controlled by timely application of Bordeaux mixture. Another disease is a rhizome or root rot causing a gradual decline in vigour of the plants. Rhizomes are often found to be rotten and covered with fungal mycelia of <i>Cephalosporium</i> sp., <i>Pythium aphanidermatum</i> and <i>P. vexans</i> . Affected plants may contain the rhizome borer <i>Prodiocetes haematicus</i> . Control measures for the disease have not been properly investigated. Other diseases of minor economic importance include a leaf rust ( <i>Uredo elettariae</i> ) and a leaf-spot ( <i>Chlamydomyces palmarum</i> )."
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). Cardamom: the genus <i>Elettaria</i> . Taylor & Francis, London	[Potentially Yes] "Cardamom is affected by a number of diseases caused by various pathogenic fungi, bacteria and nematodes, in main plantations as well as in nurseries. As many as 25 fungal, bacterial and nematodal diseases have been reported till date. Based on severity, spread and extent of damage, these are grouped as major and minor diseases occurring in the main plantations and in nurseries. Among them, four major diseases in plantations and two major diseases in nurseries seriously affect the plant and cause considerable crop damage. Major diseases such as the rots, leaf blights and nematode infestation are often wide spread and lead to crop losses while minor diseases generally affect the foliage and occur in minor proportions. Diseases alone can cause up to 50 per cent crop loss if not managed properly."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	KewScience. (2019). Plants of the World Online - <i>Elettaria cardamomum</i> . <a href="http://powo.science.kew.org">http://powo.science.kew.org</a> . [Accessed 8 Feb 2019]	"No toxicity has been reported for cardamom, but care needs to be taken that the plant being used is cardamom and not a substitute. " ... "Hazards - None known."
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Used medicinally] "Used in Ayurveda, Unani and Sidha. Ripe seeds stimulant, carminative, antispasmodic, stomachic; seeds chewed to detoxify caffeine. Dried capsule chewed, pungent taste."

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes

Qsn #	Question	Answer
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[No evidence. Unlikely given habit and habitat] "Cardamom grows wild in the shade in the forests of southern India as it does not tolerate direct sun. It thrives best in areas with uniform warm temperature 24–30°C and mean annual rainfall of 1,500 mm well distributed through out the year, on well-drained, soil rich in organic matter. Shade is important during the hot summer season and during the rainy season shade is thinned." ... "A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots."

409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Cardamom grows wild in the shade in the forests of southern India as it does not tolerate direct sun." ... "Shade is important during the hot summer season and during the rainy season shade is thinned. Cardamoms are traditionally cultivated under shade trees. Tall trees having well spaced branching habit and small leaves are ideal shade trees for cardamom."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"It thrives best in areas with uniform warm temperature 24–30°C and mean annual rainfall of 1,500 mm well distributed through out the year, on well-drained, soil rich in organic matter."
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). Cardamom: the genus <i>Elettaria</i> . Taylor & Francis, London	"Soils most favourable for growth and development of cardamom are red lateritic loam with layers of organic debris present in evergreen forests, although it grows on a variety of soils with only a shallow zone of humus accumulation. In general cardamom-growing soils are fairly deep having good drainage. The clay fraction is predominantly kaolinitic and hence there is some fixation of potassium in these soils. The cardamom-growing soils of Karnataka are mostly clay loam (Kulkarni et al., 1971)."
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). Plant resources of South-East Asia, No.13. Spices. Backhuys Publishers, Leiden, The Netherlands	"The crop does best in little-disturbed soils well supplied with organic matter and, since it does not tolerate waterlogging, with good drainage."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots."

412	Forms dense thickets	n
	Source(s)	Notes

Qsn #	Question	Answer
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[No evidence] "Cardamom grows wild in the shade in the forests of southern India as it does not tolerate direct sun. It thrives best in area"
	Global Invasive Species Database. (2019). Species profile: <i>Elettaria cardamomum</i> . <a href="http://www.iucngisd.org/gisd/species.php?sc=1299">http://www.iucngisd.org/gisd/species.php?sc=1299</a> on 09-02-2019. [Accessed 12 Feb 2019]	[Possibly Yes. May be excluding other vegetation] "The species is naturalised in La aRéunion where it is spreading in natural or semi-natural ecosystems with a relatively high density."

501	Aquatic	n
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[Terrestrial herb] "A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots."

502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 7 Feb 2019]	Family: Zingiberaceae Subfamily: Alpinioideae Tribe: Alpinieae

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 7 Feb 2019]	Family: Zingiberaceae Subfamily: Alpinioideae Tribe: Alpinieae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"A robust, perennial herb growing to 4 m high with branched subterranean rhizomes from which arises 10–12 erect leafy shoots (consist of leafy sheaths) and flowering shoots." [Not a geophyte sensu Gordon et al. (2010), but able to spread vegetatively by underground rhizomes. See Question 6.06]
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. <i>Plant Protection Quarterly</i> , 25(2): 56-74	"This question relates to perennial plants with tubers, corms or bulbs. This question is specifically to deal with plants that have specialized organs and should not include plants merely with rhizomes/ stolons"

601	Evidence of substantial reproductive failure in native habitat	n
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Global Invasive Species Database. (2019). Species profile: <i>Elettaria cardamomum</i> . <a href="http://www.iucngisd.org/gisd/species.php?sc=1299">http://www.iucngisd.org/gisd/species.php?sc=1299</a> on 09-02-2019. [Accessed 12 Feb 2019]	[IUCN recognizes as naturalized and potentially invasive. No evidence of rarity] " <i>Elettaria cardamomum</i> is a herbaceous rhizome from India valued as an aromatic. The species is naturalised in La Réunion where it is spreading in natural or semi-natural ecosystems with a relatively high density."
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[No evidence] "Cardamom is one of the world's very ancient spices. It is native to the India and Sri Lanka originating in the forests of the western Ghats in southern India, where it grows wild (Plate 1 ). Today it cultivated in India, Nepal, Sri Lanka, Guatemala, Mexico, Tanzania, Vietnam and Thailand. The major producing areas for cardamom in India are Sikkim and Kerala."

602	Produces viable seed	y
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Cardamom is propagated from seedlings, suckers or by division of the underground rhizomes."
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Propagation is by seed or division. Seeds usually germinate in four to six weeks and may take five years or more to come into production."

603	Hybridizes naturally	n
	<b>Source(s)</b>	<b>Notes</b>
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). <i>Cardamom: the genus Elettaria</i> . Taylor & Francis, London	[Only infraspecific hybrids between varieties are reported] "The breeding strategies employed for the crossbreeding pathway for cardamom improvement is given in Fig. 2.23. The popular cardamom variety namely Vazhukka possibly originated as a natural cross between var. Malabar and var. Mysore. Since cardamom is amenable to both sexual and vegetative propagation, hybridization is a very useful tool for crop improvement. As only one species occurs in India, crossing in cardamom is confined to infra-specific levels. Because of its perennial, cross-pollinated and heterozygous nature, the conventional methods for evolving homozygous lines in cardamom are time consuming. Various workers carried out, both intergeneric and intervarietal hybridizations. The former one was tried with an intention of transferring the disease resistance character. Such attempts have not been encouraging except in a report of fruit set in a cross with <i>Alpinia neutans</i> (Parameswar, 1977). All other intergeneric crosses involving <i>Amomum</i> , <i>Alpinia</i> , <i>Hedychium</i> and <i>Aframomum</i> were sterile (Krishnamurthy et al., 1989; Madhusoodanan et al., 1990)."

604	Self-compatible or apomictic	y
	<b>Source(s)</b>	<b>Notes</b>
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). <i>Cardamom: the genus Elettaria</i> . Taylor & Francis, London	"Cardamom plants have bisexual flowers. The position of the stigma and the anthers are such that pollination does not take place by itself without the help of some external pollinating agents."

Qsn #	Question	Answer
	Sinu, P. A., & Shivanna, K. R. (2007). Pollination ecology of cardamom ( <i>Elettaria cardamomum</i> ) in the Western Ghats, India. <i>Journal of Tropical Ecology</i> , 23(4), 493-496	"There was hardly any natural autogamy; only about 13% of bagged flowers set fruits and the average seed number per flower was very low ( $1.0 \pm 0.50$ SE, N=22), which was 69% (seed number= $10.3 \pm 1.52$ , N=29) and 61% (seed number= $10.2 \pm 1.68$ , N=28) in self and cross-pollinated flowers respectively; however, the difference was not statistically significant. The results clearly show that the species is self-compatible."

605	Requires specialist pollinators	n
	<b>Source(s)</b>	<b>Notes</b>
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). <i>Plant resources of South-East Asia, No.13. Spices</i> . Backhuys Publishers, Leiden, The Netherlands	"Pollination is by bees and ants."
	Kubitzki, K. (ed.). 1998. <i>The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae)</i> . Springer-Verlag, Berlin, Heidelberg, New York	"Schumann (1904) already suggested bees to be also active in pollinating species of other ground-flowering genera like <i>Elettaria</i> , <i>Geostachys</i> and <i>Elettariopsis</i> ."
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). <i>Cardamom: the genus Elettaria</i> . Taylor & Francis, London	"Structure of cardamom flower is pre-disposed for insect pollination as indicated by the prominent labellum, stigma positioning above anthers, and the presence of nectar glands." ... "Honeybees ( <i>Apis cerana</i> , <i>A. indica</i> and <i>A. dorsata</i> ) visit cardamom flowers during flowering season for collecting nectar and pollen and they do help in attaining over 90 per cent of pollination."

606	Reproduction by vegetative fragmentation	y
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. <i>Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits</i> . Springer, Dordrecht	"Cardamom is propagated from seedlings, suckers or by division of the underground rhizomes."

607	Minimum generative time (years)	>3
	<b>Source(s)</b>	<b>Notes</b>
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). <i>Plant resources of South-East Asia, No.13. Spices</i> . Backhuys Publishers, Leiden, The Netherlands	"Cardamom comes into bearing about 3 years after field planting, which may be 4-5 years after sowing. The economic life is 10-15 years."
	Staples, G.W. & Herbst, D.R. 2005. <i>A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places</i> . Bishop Museum Press, Honolulu, HI	"Propagation is by seed or division. Seeds usually germinate in four to six weeks and may take five years or more to come into production."

Qsn #	Question	Answer
701	<b>Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[Unlikely, although plants could possibly be inadvertently spread vegetatively by dumped garden waste] "Cardamom is propagated from seedlings, suckers or by division of the underground rhizomes. Cardamom is the third most expensive spice in the world as each fruit must be hand-picked."

702	<b>Propagules dispersed intentionally by people</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Cardamom reached Hawai'i by 1885 (or earlier), when six plants arrived from Jamaica. It is cultivated here only by ginger fanciers and herb and spice enthusiasts."
	van Wyk, B.-E. 2014. Culinary Herbs and Spices of the World. University of Chicago Press, Chicago, IL	"Plants can be propagated from seeds or by division. They require a tropical climate and thrive at higher latitudes in the shade of forest trees."
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Today it cultivated in India, Nepal, Sri Lanka, Guatemala, Mexico, Tanzania, Vietnam and Thailand. The major producing areas for cardamom in India are Sikkim and Kerala."

703	<b>Propagules likely to disperse as a produce contaminant</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[No evidence. Fruit valued as crop and unlikely to become a crop contaminant] "Cardamom is used in the form of whole fruit, the decorticated seeds or ground seeds." ... "Cardamom is the third most expensive spice in the world as each fruit must be hand-picked."
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	[No evidence. Unlikely. Fruit and seeds are harvested as the crop] "Propagation is by seed or division. Seeds usually germinate in four to six weeks and may take five years or more to come into production. Flowering occurs from late spring through mid- summer, and the capsules are harvested three to four months later, just before they become fully ripe. The capsules are then washed and dried and sometimes bleached with sulphur smoke."

704	<b>Propagules adapted to wind dispersal</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	"Capsule oblong, oval or oblate, 2–5 cm long, with faint longitudinal striations, roughly triangular in cross section, pale green to yellow (Plate 3 ) , trilocular with 15–20 seeds per fruit. Seed small, 3 mm long, rugose, dark brown (Plate 4 ) , aromatic, with thin mucilaginous aril."

705	<b>Propagules water dispersed</b>	

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[Unknown. Grown in wet areas. It may be possible for the plant to spread by rhizome fragments or seeds if grown near riparian areas, or during heavy rain events] "Cardamom is propagated from seedlings, suckers or by division of the underground rhizomes."

706	Propagules bird dispersed	
	<b>Source(s)</b>	<b>Notes</b>
	Chakravarthy, A. K. (1993). Vertebrate Pest Management on Cardamom ( <i>Elettaria cardamomum</i> Maton) and other crops in Malnad region. University of Agricultural Sciences, Bangalore	"Seedlings of cardamom, a plant of high economic value growing on tree holes, tree surfaces, amidst stones and boulders, stream edges, forest floors is a common sight in Mudigere. This is because squirrels, rats, spurfowl - a ground bird and shrew split cardamom capsules to feed on the mucilage and defecate seeds away from the feeding site." [Ground bird may disperse seeds]
	Kubitzki, K. (ed.). 1998. The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae). Springer-Verlag, Berlin, Heidelberg, New York	[Location of inflorescence suggests birds are unlikely to encounter fruit] In many species the arillate seeds are shed onto the ground and dispersal by ants, or mice or squirrels (Ridley 1899) is suggested. The same mode of dispersal is suggested by Maas (1977) concerning Renealmia. The inflorescence is partly or almost completely buried in species of several genera, notably in Etlingera, Elettariopsis and Elettaria. In some cases the fruit itself develops below the surface of the ground.
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	Capsule oblong, oval or oblate, 2–5 cm long, with faint longitudinal striations, roughly triangular in cross section, pale green to yellow (Plate 3) , trilocular with 15–20 seeds per fruit. Seed small, 3 mm long, rugose, dark brown (Plate 4) , aromatic, with thin mucilaginous aril." [No evidence of bird dispersal in literature. Aril may be an adaptation for ant dispersal]

707	Propagules dispersed by other animals (externally)	
	<b>Source(s)</b>	<b>Notes</b>
	Kubitzki, K. (ed.). 1998. The Families and genera of vascular plants. Volume IV. Flowering plants, Monocotyledons: Alismatanae and Commelinanae (except Gramineae). Springer-Verlag, Berlin, Heidelberg, New York	[Unknown. Aril may be adaptation for ant dispersal] "In many species the arillate seeds are shed onto the ground and dispersal by ants, or mice or squirrels (Ridley 1899) is suggested. The same mode of dispersal is suggested by Maas (1977) concerning Renealmia. The inflorescence is partly or almost completely buried in species of several genera, notably in Etlingera, Elettariopsis and Elettaria. In some cases the fruit itself develops below the surface of the ground."

708	Propagules survive passage through the gut	y
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	Mudappa, D., Kumar, A., & Chellam, R. (2010). Diet and fruit choice of the brown palm civet <i>Paradoxurus jerdoni</i> , a viverrid endemic to the Western Ghats rainforest, India. <i>Tropical Conservation Science</i> , 3(3), 282-300	"Fruits constituted the predominant diet of the brown palm civets in the region—91.12% of the 1,013 scats had fruit remains (primarily seeds) of native plant species. Fruits of 53 native species of plants from 27 families (including 8 unidentified species) were consumed by brown palm civets. Fruits of four species of exotic, introduced, or domesticated plants (banana <i>Ensete paradisiaca</i> , cardamom <i>Elettaria cardamomum</i> , coffee <i>Coffea arabica</i> , and guava <i>Psidium guajava</i> ) were also consumed. When exotic fruits were also included, 97.04% of scats contained fruit remains (primarily seeds)." ... "Appendix 1. The percent occurrence of seeds and other remains in scats (percentage of items, Fi) of the brown palm civet in the tropical rainforest of Kalakad-Mundanthurai Tiger Reserve, 1996–1999 (number of scats in parentheses)." [ <i>Elettaria cardamomum</i> seeds present in scat]
	Chakravarthy, A. K. (1993). <i>Vertebrate Pest Management on Cardamom (Elettaria cardamomum Maton) and other crops in Malnad region</i> . University of Agricultural Sciences, Bangalore	"Seedlings of cardamom, a plant of high economic value growing on tree holes, tree surfaces, amidst stones and boulders, stream edges, forest floors is a common sight in Mudigere. This is because squirrels, rats, spurfowl - a ground bird and shrew split cardamom capsules to feed on the mucilage and defecate seeds away from the feeding site."
	WRA Specialist. (2019). Personal Communication	The Hawaiian Islands lack palm civets, which have been shown to disperse seeds in their scats. Mongoose, feral pigs, and possibly rodents, could potentially disperse seeds

801	Prolific seed production (>1000/m2)	n
	Source(s)	Notes
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). <i>Cardamom: the genus Elettaria</i> . Taylor & Francis, London	"On an average, 1 kg fruits contain 900–1000 capsules with 10–15 seeds per capsule." ... "A sharp increase in national productivity of cardamom in India from 53 kg/ha (1989–90) to 173 kg/ha (1999–2000) has been recorded." [1000 capsules/kg x 15 seeds/capsule = 15000 seeds/kg; 15000 seeds/kg x 173 kg/ha = 2,595, 000 seeds/ha = 259.5 seeds/m2 in cultivated settings. Unlikely to achieve such high densities in natural conditions, and still under 1000 seeds/m2 in optimal conditions]
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). <i>Plant resources of South-East Asia, No.13. Spices</i> . Backhuys Publishers, Leiden, The Netherlands	"Seeds 15-20 per fruit, angled, about 3 mm long, rugose, dark brown, aromatic, with thin mucilaginous aril." ... "The average yield of dry capsules from a well-maintained cardamom plantation may reach 110-170 kg/ha, but 45-80 kg/ha would represent the more usual level."

802	Evidence that a persistent propagule bank is formed (>1 yr)	n
	Source(s)	Notes
	Guzman, C. C. de & Siemonsma, J. S. (eds.). (1999). <i>Plant resources of South-East Asia, No.13. Spices</i> . Backhuys Publishers, Leiden, The Netherlands	"Cardamom seeds are best sown immediately after harvest because they remain viable for only 7-10 days."

Qsn #	Question	Answer
	Ravindran, P. N., & Madhusoodanan, K. J. (Eds.). (2002). Cardamom: the genus <i>Elettaria</i> . Taylor & Francis, London	"Storage of seeds results in loss of viability and delay in germination. In a trial, germination was found to be highest in case of fresh seeds, 59 and 50.6 per cent in vars. Mysore and Malabar respectively (Korikanthimath, 1982). Germination got reduced when there was a delay in sowing after storing the seeds for longer periods especially stored in air-tight containers. Seeds treated with organo-mercurials and stored in open bottles maintained viability up to a period of 4 months. Germination was highest (71.8 per cent) when sown in September (Pattanshetty and Prasad, 1973; Pattanshetty et al., 1978). Korikanthimath (1982) observed that in a clone of var. Malabar there was a gradual decline in germination; 56.7, 51.0, 46.4, 34.1, 32.5 and 29.6 per cent when sown after 60 days in the case of seeds sown on 1st August, 15th August, 30th August, 14th September, 29th September and 14th October, respectively."

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. (2019). Personal Communication	Unknown. A valued commercial crop. No information on herbicide efficacy or chemical control of this species

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	Lim, T.K. 2013. Edible Medicinal And Non-Medicinal Plants. Volume 5, Fruits. Springer, Dordrecht	[Like other gingers, likely resprouts if top growth is removed. Unknown how frequently it can tolerate removal of foliage] "Cardamom is propagated from seedlings, suckers or by division of the underground rhizomes."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	Unknown. No evidence provided

**Summary of Risk Traits:**

## High Risk / Undesirable Traits

- Thrives in tropical climates
- Naturalized in La Reunion, Tanzania, and the Seychelles, but no evidence in the Hawaiian Islands to date
- A possible environmental weed in La Reunion (spreading in natural or semi-natural ecosystems with a relatively high density)
- Shade tolerant (could spread in forest understory)
- Reproduces by seeds and vegetatively by rhizomes
- Self-compatible (but with lower seed set)
- Seeds dispersed by animals, and intentionally by people

## Low Risk Traits

- Generally regarded as a high value spice crop
- Unarmed (no spines, thorns, or burrs)
- Reaches maturity in 5+ years
- Fruit and seeds are the valued crop, and unlikely to be accidentally dispersed
- Seeds lose viability rapidly (no formation of seed bank)

## Second Screening Results for Herbs or Low Stature Shrubby Life Forms

(A) Reported as a weed of cultivated lands?> No

Outcome = Accept (Low Risk)