

Taxon: <i>Tylosema esculentum</i> (Burch.) A. Schreib.	Family: Fabaceae
Common Name(s): camel's foot gemsbok bean marama bean tamami thamani berry	Synonym(s): <i>Bauhinia esculenta</i> Burch.

Assessor: Chuck Chimera	Status: Approved	End Date: 26 Aug 2024
WRA Score: -6.0	Designation: L	Rating: Low Risk

Keywords: Perennial Herb, Tuberos, Edible, Vining Stems, Dehiscent Pods

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	n
302	Garden/amenity/disturbance weed	y = 1*multiplier (see Appendix 2), n = 0	n
303	Agricultural/forestry/horticultural weed	y = 2*multiplier (see Appendix 2), n = 0	n
304	Environmental weed	y = 2*multiplier (see Appendix 2), n = 0	n
305	Congeneric weed		
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		
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans		
408	Creates a fire hazard in natural ecosystems	y = 1, n = 0	n

Qsn #	Question	Answer Option	Answer
409	Is a shade tolerant plant at some stage of its life cycle	y = 1, n = 0	n
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	y
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	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	2
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	n
707	Propagules dispersed by other animals (externally)	y = 1, n = -1	n
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m ²)	y = 1, n = -1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)		
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
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	[Not domesticated] "Programmes for selection and breeding work of marama bean are recorded to be underway in the United States, Australia and Israel. RAPD analysis of 3 populations from various parts of Botswana has shown that a considerable amount of genetic variation exists within marama bean, most of it within rather than between populations. Sufficient genetic variation for breeding may be found by sampling 30-40 plants from 1 or 2 populations."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2024). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2024). 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
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Marama bean is native to the Kalahari desert and neighbouring sandy regions in Angola, Namibia, Botswana and South Africa, but it also occurs in Zambia and Mozambique. Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."

202	Quality of climate match data	High
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Marama bean is native to the Kalahari desert and neighbouring sandy regions in Angola, Namibia, Botswana and South Africa, but it also occurs in Zambia and Mozambique. Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Marama bean occurs naturally in an extreme environment with high temperatures (typical daily maximum of 37°C in the growing season), low rainfall (100-900 mm) and long periods of drought. It is found on sandy and limestone (including dolomite) soils, but not on soils developed over granite or basalt. Marama bean is found in grassland and wooded grassland vegetation. It occurs in localized patches."

Qsn #	Question	Answer
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	"The marama survives in regions where few conventional crops survive, yet it appears adapted to a wide range of climatic conditions. Obviously, the plant's environmental requirements are at present far from certain but the following seems a reasonable summary. Rainfall Mainly, marama grows where rain is so slight and erratic that in some years almost no moisture falls at all. In some locations, even in the best of times, the rains last for only two months a year. The sparse precipitation arrives during short-lived torrential thunderstorms in spring and fall. The rest of the year remains almost rainless. Usually, however, there is subsoil moisture that the deep roots tap into. Indeed, in fine-grained sandy soils, water may remain in the root zone for months after rain. Marama also exists in well-watered locations receiving up to 800 mm annual rainfall. Altitude The plant is found in a region lacking in mountains, but altitude seems hardly likely to be a limitation by itself. Low Temperature In winter, when the plant is dormant, temperatures plunge very low (by African standards). Winter nights can be freezing and the days frosty. High Temperature Very high summer temperatures to 47 °C in the shade and sometimes over 50° have been reported."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Marama bean is native to the Kalahari desert and neighbouring sandy regions in Angola, Namibia, Botswana and South Africa, but it also occurs in Zambia and Mozambique. Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	"Reported in California, Texas, and Florida in the USA, Queensland in Australia, and Israel, and some botanic gardens. It has curiously become a favorite of some bonsai enthusiasts, so probably now has a broader, yet still small-scale distribution."

Qsn #	Question	Answer
301	Naturalized beyond native range	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	[No evidence] "Marama bean is native to the Kalahari desert and neighbouring sandy regions in Angola, Namibia, Botswana and South Africa, but it also occurs in Zambia and Mozambique. Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."
	National Research Council. (2006). Lost Crops of Africa: Volume II: Vegetables. National Academies Press, Washington, D.C.	[No evidence] "Reported in California, Texas, and Florida in the USA, Queensland in Australia, and Israel, and some botanic gardens. It has curiously become a favorite of some bonsai enthusiasts, so probably now has a broader, yet still small-scale distribution."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	Gallaher, T.J., Brock, K., Kennedy, B.H., Imada, C.T., Imada, K., & Walvoord, N. (2024). Plants of Hawai'i. http://www.plantsofhawaii.org . [Accessed 23 Aug 2024]	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
	CABI. (2024). CABI Compendium Invasive Species. https://www.cabidigitallibrary.org/product/qi . [Accessed 23 Aug 2024]	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
	CABI. (2024). CABI Compendium Invasive Species. https://www.cabidigitallibrary.org/product/qi . [Accessed 23 Aug 2024]	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
	CABI. (2024). CABI Compendium Invasive Species. https://www.cabidigitallibrary.org/product/qi . [Accessed 23 Aug 2024]	No evidence

305	Congeneric weed	
	Source(s)	Notes

Qsn #	Question	Answer
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[Cited as an agricultural weed. Impacts unknown] "Tylosema fassoglensis (Kotschy) Torre & Hillc. Fabaceae - Caesalpiniaceae Total N° of Refs: 1 Habit: Shrub Preferred Climate/s: Dryland, Tropical Major Pathway/s: Crop, Ornamental Dispersed by: Humans References: Tanzania-A-2076."
	CABI. (2024). CABI Compendium Invasive Species. https://www.cabidigitallibrary.org/product/qi . [Accessed 26 Aug 2024]	No evidence

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	[No evidence] "Perennial herb or shrub, with tuberous root; stems prostrate and trailing, up to 6 m long, herbaceous or lower parts woody, rusty-hairy, with axillary forked tendrils 1-4 cm long. Leaves alternate, simple; stipules 3-5 mm × 2-3 mm; petiole 1.5-3.5 cm long; blade 2-lobed for more than half its length, glabrous or pubescent beneath; lobes reniform, 3.5-5 cm × 5-6.5 cm. Inflorescence a lateral raceme up to 16 cm long; peduncle 2-4 cm long. Flowers bisexual, zygomorphic, 5-merous, heterostylous; pedicel 2-4.5 cm long; sepals free but upper 2 fused, 8-12 mm × 2-3 mm, rusty-hairy; petals unequal, 4 larger ones 1.5-2.5 cm × 1-1.5 cm and tapering into a basal claw, the upper one smaller, yellow turning reddish with age; stamens 2, free, with filaments 6-12 mm long, staminodes 8, with filaments 3-6 mm long; ovary superior, 5-6 mm long, 1-celled, style elongate, stigma small. Fruit an ovoid to oblong pod 3.5-6 cm × 3-4 cm, flattened, woody, 1-2(-6)-seeded, constricted between the seeds. Seeds ovoid to globose, 1.3-2.5 cm × 1.2-1.5 cm, reddish to brownish black."

402	Allelopathic	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	[Unknown. No evidence found] "Marama bean is found in grassland and wooded grassland vegetation. It occurs in localized patches."

403	Parasitic	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Perennial herb or shrub, with tuberous root; stems prostrate and trailing, up to 6 m long, herbaceous or lower parts woody, rusty-hairy, with axillary forked tendrils 1-4 cm long."

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"The pods and tubers are recorded to be eaten by animals, but it is not clear whether the foliage is browsed, as contradictory reports exist."

405	Toxic to animals	n

Qsn #	Question	Answer
	Source(s)	Notes
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Palatable, but with possibly toxic constituents] "seeds eaten boiled or roasted, immature seeds and stems eaten cooked as a vegetable, young tubers eaten, tubers emergency source of water, pods and tubers eaten by animals, a source of oil from the seeds" ... Recorded presence of toxic constituents or antinutritional factors in the seeds and tubers."
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	[Possibly with toxic constituents] "Furthermore, genetic improvement and germplasm collection need attention and research should be carried out on the presence of toxic constituents or antinutritional factors in the seeds and tubers."

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Bagai, K. (2020). Identification of mongongo (<i>Schinziophyton rautanenii</i>) and morama (<i>Tylosema esculentum</i>) insect pests and their natural enemies in Botswana. Master of Science Thesis. Botswana University of Agriculture and Natural Resources, Gaborone, Botswana	"The study was conducted at the Botswana University of Agriculture and Natural Resources (BUAN) Sebele, Gaborone. Sampling sites for this study was done in Kweneng district and Okavango district, and the experiments were conducted in the entomology lab during 2016/2017 season. Farmer's knowledge on insect pests of morama and mongongo were investigated by interviewing 150 users of morama in Kweneng district and 150 users of mongongo in Okavango. Most of the farmers gathered mongongo and morama in the forest and stored them in woven polypropylene bags. They considered insect, wild and domesticated animals as a major constraint of mongongo and morama production. Beetles and caterpillars were identified as the major insect pests of the fruits and seeds in storage. None of the farmers use pesticides to control these pests. Majority of the respondents do not use any pest control. Eleven different insect species were identified to be hosted by mongongo tree in the forest and two insect species in storage (<i>Lasioderma serricorne</i> and <i>Plodia interpunctella</i>). Six insect species were hosted by morama in the forest and two insect species in storage (<i>Plodia interpunctella</i> and <i>Tribolium confosum</i>). There was no significant difference ($P>0.05$) between storage methods (jute bag, woven polypropylene bag and bottle container) on managing the infestation insect population. Natural enemies (<i>B. hebetor</i>) has significantly effect ($P<0.05$) on the population of storage pest (<i>P.interpunctella</i>)."

407	Causes allergies or is otherwise toxic to humans	
	Source(s)	Notes
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Edible, but with possibly toxic constituents] "seeds eaten boiled or roasted, immature seeds and stems eaten cooked as a vegetable, young tubers eaten, tubers emergency source of water, pods and tubers eaten by animals, a source of oil from the seeds" ... Recorded presence of toxic constituents or antinutritional factors in the seeds and tubers."

Qsn #	Question	Answer
408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 26 Aug 2024]	[No evidence. Plants persist from tubers during dry periods. Unlikely to contribute to fuel load when fire risks are high] "The stems die back at the end of the summer growing season, and the tuber becomes dormant during the dry, cold winter, resprouting in spring, when the warm, rainy weather returns. <i>Tylosema esculentum</i> is drought-tolerant, and is able to survive periods of drought because it can draw on water reserves stored in the tuber, and it can close its leaves and stomata to reduce the exposed leaf area and prevent water loss."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 21 Aug 2024]	"Grow <i>Tylosema esculentum</i> in well-drained, sandy, compost-enriched soil in full sun, and water well in spring and summer."
	Plants for a Future. (2024). <i>Tylosema esculentum</i> . https://pfaf.org/user/Plant.aspx?LatinName=Tylosema+esculentum . [Accessed 21 Aug 2024]	"It cannot grow in the shade."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"It is found on sandy and limestone (including dolomite) soils, but not on soils developed over granite or basalt."
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	"Soil: Marama beans prefer neutral to acid soil. It is particularly prominent on the brick-red sand of the inland Namib Desert. Grows on deep sand but also where there are outcrops of dolomite; also has been grown on neutral shaly soils."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	"The plant is not a climber; it grows prostrate, sending viney stems creeping out over the soil surface in several directions. These runners are up to 6 m long and form a dense, geometrical pattern of overlapping whorls of stems, hugging the ground, presumably to avoid the drying winds. The vines carry double-lobed leaves that are soft and red-brown when young, turning leathery and gray-green with age."

412	Forms dense thickets	n
	Source(s)	Notes
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 22 Aug 2024]	" <i>Tylosema esculentum</i> occurs across the northern parts of southern Africa, in South Africa, Namibia and Botswana and extending into Angola and Zimbabwe. In South Africa, <i>T. esculentum</i> is found in northern Gauteng, Limpopo, North West and the Northern Cape. It is localized in patches of grassland and wooded grassland vegetation in sandy and limestone (including dolomite) soils, but not on soils developed over granite or basalt."

Qsn #	Question	Answer
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	[Forms dense cover of stems] "The plant is not a climber; it grows prostrate, sending viney stems creeping out over the soil surface in several directions. These runners are up to 6 m long and form a dense, geometrical pattern of overlapping whorls of stems, hugging the ground, presumably to avoid the drying winds."
501	Aquatic	n
	Source(s)	Notes
	Eggli, U. & Nyffeler, R. (eds.). (2023). <i>Illustrated Handbook of Succulent Plants: Dicotyledons: Rosids</i> . Springer-Verlag, Berlin, Heidelberg, New York	[Terrestrial] "sandy plains, more rarely grassy places, esp. on dolomite and limestone outcrops, 900-1500 m."
502	Grass	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2024). <i>Germplasm Resources Information Network (GRIN-Taxonomy)</i> . National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch . [Accessed 21 Aug 2024]	"Genus: <i>Tylosema</i> Family: Fabaceae (alt. Leguminosae) Subfamily: Cercidoideae Tribe: Cercideae Subtribe: Bauhiniinae"
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Marama bean does not form root nodules and relies on soil nitrogen."
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"In southern Africa the stems die back during the dry and cool period (May-August), but the tuber remains viable and produces new stems when the temperature rises."
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. <i>PlantZAfrica</i> . SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 21 Aug 2024]	"The stems die back at the end of the summer growing season, and the tuber becomes dormant during the dry, cold winter, resprouting in spring, when the warm, rainy weather returns. <i>Tylosema esculentum</i> is drought-tolerant, and is able to survive periods of drought because it can draw on water reserves stored in the tuber, and it can close its leaves and stomata to reduce the exposed leaf area and prevent water loss."

Qsn #	Question	Answer
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 22 Aug 2024]	"Conservation Status: <i>Tylosema esculentum</i> is widespread and not in danger of extinction. According to the Red List of South African Plants, the conservation status of this species is Least Concern (LC)."
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Marama bean is considered neither rare nor threatened."

602	Produces viable seed	y
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Propagation of marama bean is by seed. Germination is sometimes said to be improved by scarification. Soaking will kill the seed and it should not be sown in waterlogged soils. The 1000-seed weight is 2-3 kg. "
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 21 Aug 2024]	"Propagation of <i>Tylosema esculentum</i> is done by seed and has a relatively high germination and emergence percentage, confirming that marama bean seeds have no physiological dormancy. However, scarification of <i>T. esculentum</i> seeds has been shown to improve germination but the seeds should not be pre-soaked. Germination starts to take place after approximately 9 days. Once germinated, the seedlings develop rapidly."

603	Hybridizes naturally	n
	Source(s)	Notes
	Masters, L. (2020). <i>An Investigation into the Systematics and Population Diversity of Tylosema (Leguminosae)</i> (Master's thesis, University of Pretoria, Pretoria, South Africa)	[No evidence] "The two SHMT sequences in <i>T. esculentum</i> (both lineages) individuals are not the result of a hybridization event between two other <i>Tylosema</i> species. This is because the two sequences present in each individual grouped together, as opposed to one grouping with either <i>T. fassoglense</i> or <i>T. angolense</i> . <i>T. esculentum</i> is also a known polyploid, an autopolyploid according to Mornaghan (1995), and the lack of hybridization evidence from the SHMT marker provides support for this finding."

604	Self-compatible or apomictic	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"It is predominantly outcrossing and may be self-incompatible; it is pollinated by insects."

Qsn #	Question	Answer
	Hartley, M. L., Tshamekeng, E., & Thomas, S. M. (2002). Functional heterostyly in <i>Tylosema esculentum</i> (Caesalpinioideae). <i>Annals of Botany</i> , 89(1), 67-76	" <i>Tylosema esculentum</i> is a long-lived perennial species endemic to arid areas of southern Africa. Its potential as a crop species has long been recognized as a result of the high oil and protein content of its seeds. The reproductive biology and breeding systems of the species were investigated in wild and experimental populations growing in Botswana. Field observations confirmed that the species is heterostylous with the pistil and anthers exhibiting reciprocal heights in the two morphs, although pollen size and sculpturing do not vary. The wet, nonpapillate stigma characteristic of the species is the first to be reported in the Caesalpinioideae. In vivo and in vitro diallel crossing experiments demonstrated that a diallelic self-incompatibility system exists in <i>T. esculentum</i> . The major site of pollen tube inhibition in the intramorph crosses was found to be in the style. This is the first report of functional heterostyly in the Fabaceae and of a confirmed self-incompatibility system in the Caesalpinioideae. Three separate lines of evidence, the monitoring of fruit development in open-pollinated plants, fruit set in diallel crossing experiments, and observations made in wild populations, demonstrated that fruit set and, by implication, seed set, are very low in this species. Floral abscission was a major limitation to the production of mature pods but there were also significant losses at other developmental stages of fruit production. The results suggest that low seed set may be an adaptation of the species to an environment in which rainfall is scarce."

605	Requires specialist pollinators	n
	Source(s)	Notes
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	"Golden-yellow, insect-pollinated blossoms develop in midsummer (December/January in southern Africa) and the fruits ripen in late autumn (April)."
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"It is predominantly outcrossing and may be self-incompatible; it is pollinated by insects."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses</i> . PROTA Foundation. Wageningen, Netherlands	"Propagation of marama bean is by seed. Germination is sometimes said to be improved by scarification. Soaking will kill the seed and it should not be sown in waterlogged soils. The 1000-seed weight is 2-3 kg. Preliminary results under laboratory conditions show that vegetative propagation using sprouts is possible." [No evidence]
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. <i>PlantZAfrica</i> . SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 22 Aug 2024]	"Propagation of <i>Tylosema esculentum</i> is done by seed and has a relatively high germination and emergence percentage, confirming that marama bean seeds have no physiological dormancy. However, scarification of <i>T. esculentum</i> seeds has been shown to improve germination but the seeds should not be pre-soaked. Germination starts to take place after approximately 9 days. Once germinated, the seedlings develop rapidly."
	National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables</i> . National Academies Press, Washington, D.C.	[No evidence that the viney stems break off or root to establish separate plants] "The plant is not a climber; it grows prostrate, sending viney stems creeping out over the soil surface in several directions. These runners are up to 6 m long and form a dense, geometrical pattern of overlapping whorls of stems, hugging the ground, presumably to avoid the drying winds. The vines carry double-lobed leaves that are soft and red-brown when young, turning leathery and gray-green with age."

Qsn #	Question	Answer
	Chimwamurombe, P. M. (2016). Domestication of [<i>Tylosema esculentum</i> (Burchell) schreiber](Marama bean): a work in progress in Namibia. <i>Biosciences Biotechnology Research Asia</i> , 8(2), 549-556	[No evidence] "In its natural stands, marama bean takes between 18-24 months to reach reproduction maturity. It takes between 8-21 days to germinate on wet soils and then the plant grows vegetatively (Figure 2) for the next 5-6 months. During this time a tuber will be developing underground. This tuber will sustain the plant nutritionally in the coming winter times when all the runners die back and shrivel off."

607	Minimum generative time (years)	2
Source(s)		Notes
Bagai, K. (2020). Identification of mongongo (<i>Schinziophyton rautanenii</i>) and morama (<i>Tylosema esculentum</i>) insect pests and their natural enemies in Botswana. Master of Science Thesis. Botswana University of Agriculture and Natural Resources, Gaborone, Botswana		"In its natural stands, morama bean takes between 18-24 months to reach reproduction maturity."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
Source(s)		Notes
Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses.</i> PROTA Foundation. Wageningen, Netherlands		"Fruit an ovoid to oblong pod 3.5-6 cm × 3-4 cm, flattened, woody, 1-2 (-6)-seeded, constricted between the seeds. Seeds ovoid to globose, 1.3-2.5 cm × 1.2-1.5 cm, reddish to brownish black." [No evidence. Pods and seeds large and lack means of external attachment]
Chimwamurombe, P. M. (2016). Domestication of [<i>Tylosema esculentum</i> (Burchell) schreiber](Marama bean): a work in progress in Namibia. <i>Biosciences Biotechnology Research Asia</i> , 8(2), 549-556		"The seed usually shatter off a brown dry marama pod powerfully for seed dispersal. The pod starts with a purplish colour, and then it becomes green as the seeds inside mature and final turn brown when the seeds are dispersal-ready."

702	Propagules dispersed intentionally by people	y
Source(s)		Notes
Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses.</i> PROTA Foundation. Wageningen, Netherlands		"Experimental cultivation in Kenya, South Africa, Australia, Israel and the United States (Texas) has been successful."
National Research Council. (2006). <i>Lost Crops of Africa: Volume II: Vegetables.</i> National Academies Press, Washington, D.C.		"Reported in California, Texas, and Florida in the USA, Queensland in Australia, and Israel, and some botanic gardens. It has curiously become a favorite of some bonsai enthusiasts, so probably now has a broader, yet still small-scale distribution."

703	Propagules likely to disperse as a produce contaminant	n
Source(s)		Notes
Brink, M. & Belay, G. (Editors). (2006). <i>Plant Resources of Tropical Africa. Volume 1. Cereals and pulses.</i> PROTA Foundation. Wageningen, Netherlands		"Fruit an ovoid to oblong pod 3.5-6 cm × 3-4 cm, flattened, woody, 1-2 (-6)-seeded, constricted between the seeds. Seeds ovoid to globose, 1.3-2.5 cm × 1.2-1.5 cm, reddish to brownish black." [No evidence. Pods and seeds large and unlikely to become a seed contaminant]

704	Propagules adapted to wind dispersal	n
Source(s)		Notes

Qsn #	Question	Answer
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Fruit an ovoid to oblong pod 3.5-6 cm × 3-4 cm, flattened, woody, 1-2 (-6)-seeded, constricted between the seeds. Seeds ovoid to globose, 1.3-2.5 cm × 1.2-1.5 cm, reddish to brownish black." [Flattened pods may facilitate some movement by wind, but otherwise no adaptations for wind dispersal exist]
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"The seed usually shatter off a brown dry marama pod powerfully for seed dispersal. The pod starts with a purplish colour, and then it becomes green as the seeds inside mature and final turn brown when the seeds are dispersal-ready." [Not adapted for wind dispersal, but wind may contribute to further movement of seeds]

705	Propagules water dispersed	
	Source(s)	Notes
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"The seed usually shatter off a brown dry marama pod powerfully for seed dispersal. The pod starts with a purplish colour, and then it becomes green as the seeds inside mature and final turn brown when the seeds are dispersal-ready." [Possibly, if cultivated near water, but no direct evidence found]

706	Propagules bird dispersed	n
	Source(s)	Notes
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"The seed usually shatter off a brown dry marama pod powerfully for seed dispersal. The pod starts with a purplish colour, and then it becomes green as the seeds inside mature and final turn brown when the seeds are dispersal-ready."

707	Propagules dispersed by other animals (externally)	n
	Source(s)	Notes
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"The seed usually shatter off a brown dry marama pod powerfully for seed dispersal. The pod starts with a purplish colour, and then it becomes green as the seeds inside mature and final turn brown when the seeds are dispersal-ready."

708	Propagules survive passage through the gut	
	Source(s)	Notes
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"The pods and tubers are recorded to be eaten by animals, but it is not clear whether the foliage is browsed, as contradictory reports exist." [Unknown if seeds consumed can survive gut passage. Unlikely to be an important dispersal vector]

801	Prolific seed production (>1000/m2)	n
	Source(s)	Notes
	Chimwamurombe, P. M. (2016). Domestication of [Tylosema esculentum (Burchell) schreiber](Marama bean): a work in progress in Namibia. Biosciences Biotechnology Research Asia, 8(2), 549-556	"Generally, the plant is low yielding, producing few seeds (one to two seeds per pod). So collecting seed in the wild is not a sustainable way of alleviating the malnutrition problems of this Southern African region. The plant needs to be developed into a crop with cultivars that are high yielding and early maturing."

802	Evidence that a persistent propagule bank is formed (>1 yr)	

Qsn #	Question	Answer
	Source(s)	Notes
	Brink, M. & Belay, G. (Editors). (2006). Plant Resources of Tropical Africa. Volume 1. Cereals and pulses. PROTA Foundation. Wageningen, Netherlands	"Germination is sometimes said to be improved by scarification. Soaking will kill the seed and it should not be sown in waterlogged soils. " ... "Marama bean shows orthodox seed storage behaviour." [Longevity under natural conditions unknown]
	Travlos, I. S., Economou, G., & Karamanos, A. I. (2007). Germination and emergence of the hard seed coated <i>Tylosema esculentum</i> (Burch.) A. Schreib in response to different pre-sowing seed treatments. <i>Journal of Arid Environments</i> , 68(3), 501-507	"Marama seeds are relatively large, with a hard seed coat, able to resist mechanical damage, likewise seeds of other perennial legume species (Hyde, 1954). In the nature, there are various biotic and abiotic factors that promote seed scarification, such as mechanical abrasion of the seed coat by sand and rocks in water courses (Vilela and Ravetta, 2001)." [Unknown how long seeds will persist in the soil]

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. (2024). 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
	Bagai, K. (2020). Identification of mongongo (<i>Schinziophyton rautanenii</i>) and morama (<i>Tylosema esculentum</i>) insect pests and their natural enemies in Botswana. Master of Science Thesis. Botswana University of Agriculture and Natural Resources, Gaborone, Botswana	"It is dormant in winter and regrows from the tuber in spring." [Might be able to recover from damage through regrowth from tubers]
	Malwane, T. & le Roux, M. (2022). <i>Tylosema esculentum</i> (Burch.) A. Schreib. PlantZAfrica. SANBI. https://pza.sanbi.org/tylosema-esculentum . [Accessed 26 Aug 2024]	"The stems die back at the end of the summer growing season, and the tuber becomes dormant during the dry, cold winter, resprouting in spring, when the warm, rainy weather returns."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	WRA Specialist. (2024). Personal Communication	Unknown

Summary of Risk Traits:

Tylosema esculentum, commonly known as the marama bean or gemsbok bean, is a leguminous plant native to Southern Africa, particularly found in countries like Namibia, Botswana, and South Africa. It is adapted to arid environments and is considered a valuable food source in the regions where it grows. Marama beans are consumed locally and are a significant food resource in the regions where the plant is native. The seeds have a nutty flavor and can be used in various culinary applications, similar to peanuts or other legumes. It is not currently documented to be naturalized or invasive outside its native range.

High Risk / Undesirable Traits

- Thrives and can potentially spread in regions with tropical climates
- Broad climate suitability
- Raw seeds and tubers may contain toxic constituents
- Tuberos roots allow the plant to survive drought and cool weather
- Reproduces by seed
- Reaches maturity in 18-24 months
- Seeds dispersed by dehiscent pods and intentional cultivation
- Orthodox seeds may form a persistent seed bank

Low Risk Traits

- No reports of invasive or negative impacts where cultivated
- Unarmed (no spines, thorns, or burrs)
- Palatable to animals
- Grows best in high light environments (dense shade may inhibit spread)
- Relatively large pods and seeds unlikely to be accidentally spread