

Taxon: Cenchrus ciliaris	Family: Poaceae
Common Name(s): buffelgrass Laredo buffelgrass	Synonym(s): Cenchrus glaucus C. R. Mudaliar & Pennisetum cenchroides Rich. Pennisetum ciliare (L.) Link Pennisetum incomptum Nees

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 4 Feb 2015
WRA Score: 19.0	Designation: H(Hawai'i)	Rating: High Risk

Keywords: Invasive, Forage Grass, Fire Hazard, Apomictic, Wind-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed		
303	Agricultural/forestry/horticultural weed		
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	y
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
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	y=1, n=-1	n
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	y

Qsn #	Question	Answer Option	Answer
409	Is a shade tolerant plant at some stage of its life cycle		
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	y
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	y
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	y
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	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m ²)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	y
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	n

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"The promotion of planting of <i>C. ciliaris</i> in other regions has been relatively recent, so additional invasion sites are likely in the future. Furthermore, planting of new cultivars with wider environmental tolerances may promote more extensive invasions."
	Hauser, A. S. 2008. <i>Pennisetum ciliare</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). http://www.fs.fed.us/database/feis/ . [Accessed 3 Feb 2015]	[Unknown, but no evidence found thus far that indicates cultivar 'Laredo' is significantly different from the wild type] "As an introduced forage plant, there are numerous buffelgrass cultivars available in North America [9,101,126], which vary in reproductive and morphological characteristics [126,131]. Most of these cultivars were derived from the strain first introduced to and most common in North America, 'T-4464'. This strain is referred to as "common buffelgrass" in this review [110]. Most of the literature included in this review does not identify buffelgrass by cultivar or strain. Therefore, in this review, "buffelgrass" refers to the species in general."
102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2015. Personal Communication	NA
103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2015. 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
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Tropical Africa, Middle East, India, Pakistan, Syria"
202	Quality of climate match data	High
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	
203	Broad climate suitability (environmental versatility)	y

Qsn #	Question	Answer
	Source(s)	Notes
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	[Broad latitudinal & elevation range] "Found from about 33°S in South Africa to about 35°N in Syria and 37°N in Sicily, and from sea level to 2,500 m asl. This equates to a distributional range of the species over regions with average annual temperatures from about 12-28°C. Optimum temperature for photosynthesis in varieties measured is 35°C, and minimum between 5 and 16°C. Relative growth rate rises steeply from 15/10°-30/25°C, with a small further increment to 36/31°C. Some varieties are better adapted to cooler environments than others. Winter survival varies with ecotype, some surviving to -7°C. Tops are killed by frost but plants mostly recover with resumption of warmer conditions. In general, performs best in areas where mean minimum winter temperatures are >5°C."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Africa and tropical Asia, naturalized elsewhere in the Old World; in Hawaii naturalized and common in dry areas and sandy soil in a wide variety of disturbed habitats, 0-120 m, on all of the main islands except Niihau."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Marshall et al. (2012) provide an historical overview of introductions of <i>C. ciliaris</i> around the world. In general, deliberate introductions were made for forage in dry tropical and subtropical environments beginning in the early 1900s. An interesting exception was the introduction of the species to central Australia by Afghan cameleers in the 1870s (Humphreys, 1967). Between the 1950s and the 1970s, large scale plantings were made in Australia and the United States, and from there <i>C. ciliaris</i> was widely marketed and distributed by governmental and non-profit organizations as a "wonder crop". Today, it has probably been introduced to every warm, arid region of the world, although records are not available for every country or oceanic island. Major areas of spread as an invasive plant include Australia, Mexico, and the United States (including Hawaii). In the West Indies this species is listed as invasive in Cuba, Puerto Rico and The Virgin Islands (Acevedo and Strong, 2012). The first record of <i>C. ciliaris</i> within this region was made in Puerto Rico in 1915 (US National Herbarium)."

301	Naturalized beyond native range	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Major <i>C. ciliaris</i> invasions have occurred in Australia, the southwestern United States, Mexico, and Hawaii (Weber (2003) lists it as invasive in Australia, Hawaii and the western USA)."

Qsn #	Question	Answer
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Africa and tropical Asia, naturalized elsewhere in the Old World; in Hawaii naturalized and common in dry areas and sandy soil in a wide variety of disturbed habitats, 0-120 m, on all of the main islands except Niihau."

302	Garden/amenity/disturbance weed	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Invades disturbed areas, becoming an ecological weed, and perhaps negatively impacting agriculture] " <i>C. ciliaris</i> grows in a variety of arid and semi-arid habitats, in particular those subject to disturbance."

303	Agricultural/forestry/horticultural weed	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Impacts not quantified] "In its native range, <i>C. ciliaris</i> is reported as a weed of various crops including chickpea <i>Cicer arietinum</i> (Marwat et al., 2004), cotton (Rajput et al., 2008), potato (Shedayi et al., 2011) and maize <i>Zea mays</i> (Zair Muhammad, 2011), but specific impacts of the species on crops have not been quantified." ... " <i>C. ciliaris</i> invasion in Australia is apparently leading to declines in some traditional Aboriginal food plants such as spinifex (<i>Triodia</i> sp.) (Low, 1997). In its native range, <i>C. ciliaris</i> stands harbour ticks that carry human and wildlife diseases (Wanzala and Okanga, 1996), and it is conceivable that humans and animals walking in areas invaded by the species will be more susceptible to tick bites, as compared to the more open groundcover that existed prior to invasion. Fires promoted by <i>C. ciliaris</i> can threaten homes and other structures and facilities utilized by people."
	Marshall, V. M., Lewis, M. M., & Ostendorf, B. 2012. Buffel grass (<i>Cenchrus ciliaris</i>) as an invader and threat to biodiversity in arid environments: a review. <i>Journal of Arid Environments</i> , 78: 1-12	[No mention of impacts to agriculture] "Popular pastoral species, Buffel grass (<i>Cenchrus ciliaris</i>) is receiving long overdue attention as an invasive weed that poses serious threats to biodiversity conservation worldwide"

304	Environmental weed	y
	Source(s)	Notes
	Marshall, V. M., Lewis, M. M., & Ostendorf, B. 2012. Buffel grass (<i>Cenchrus ciliaris</i>) as an invader and threat to biodiversity in arid environments: a review. <i>Journal of Arid Environments</i> , 78: 1-12	"Buffel grass invasion can devastate local ecosystems by altering wildfire regimes, soil erosion rates, ground surface temperatures and supply of vital resources to surrounding life forms, compromising biodiversity (D'antonio and Vitousek, 1992). Significant invasions have been reported in arid communities throughout Australia, the USA, Mexico and South America and many species and ecosystem functions have been impacted (Table 5)."
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"In Australia, Fairfax and Fensham (2000) found that plant species diversity was significantly lower in <i>C. ciliaris</i> pastures as compared to native grass pastures." ... "In some cases, rare animal species are threatened by <i>C. ciliaris</i> invasion. "

Qsn #	Question	Answer
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"This small, perennial bunchgrass forms continuous cover in arid habitats. The dried shoots provide an excellent fuel for fire, from which the plant recovers rapidly by basal shoots. It is a fire-enhanced species as its cover increases with each succeeding fire. The seeds are dispersed by wind. It has not been evaluated for biological control, because of its extensive use in erosion control. The species is confined to arid habitats between sea level and 150 m elevation. There are major infestations at Lualualei, O'ahu; Kihei, Maui; on Kahoolawe; and at Kawaihae, Hawaii. It has recently become the dominant grass on Molokini Island."

305	Congeneric weed	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus echinatus</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>C. echinatus</i> occurs as a weed in many crops worldwide. It is common in cultivated fields, pastures, fallows, orchards, vineyards, coffee, vegetables, bananas, coconuts and lawns, where it can withstand repeated defoliation. It can be found along roadsides and beaches, in open ground and waste places. Crops competing for nutrients with <i>C. echinatus</i> typically have smaller leaf areas and lower growth rates and yields (Hammerton, 1981; Everaarts, 1993; Ramos and Pitelli, 1994). The burs of the seed heads can become firmly attached to clothes and coats of animals by the barbed spines. These can penetrate the skin causing painful or annoying injuries. In feeds and hay, the burs of the seed heads reduce the acceptability and palatability of the feed to animals. Nevertheless, it can serve as a forage grass before the burs are formed. <i>C. echinatus</i> also has some relevance as an alternative host for maize streak monogeminivirus and sugarcane streak monogeminivirus (Brunt et al., 1996)."

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Perennial [grass], sometimes short-rhizomatous and forming mats or tussocks; culms ascending, 10-150 cm tall, 1-2 mm in diameter, wiry or sometimes almost woody at base, sometimes many branched from lower or basal nodes. Sheaths keeled, glabrous or sparsely pilose; ligule a densely ciliate membrane 0.5-2.5 mm long; blades 3-25 cm long, 2-13 mm wide, glabrous or sparsely pilose, apex caudate."

402	Allelopathic	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Possibly] "The possibility of allelopathy by <i>C. ciliaris</i> is supported by laboratory assays in which <i>C. ciliaris</i> leachates reduced germination of other species (Fulbright and Fulbright 1990; Farrukh Hussain et al., 2011), but these findings need to be confirmed in field studies."

403	Parasitic	n
-----	-----------	---

Qsn #	Question	Answer
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Perennial bunchgrass..." [Poaceae]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	"Generally less palatable than <i>Panicum coloratum</i> and <i>P. maximum</i> but more palatable than <i>Setaria incrassata</i> ."
	Pacific Seed Company. 2012. Laredo Buffelgrass (<i>Pennisetum ciliaris</i> L.). Pacific International Seed Company, Inc., Walnut Creek, CA. http://www.pacificseed.com/productPDF/Laredo.pdf . [Accessed 3 Feb 2015]	"Laredo buffelgrass is a highly nutritious grass and is considered excellent for pasture in hot, dry areas and is valued for its production of palatable forage and intermittent grazing during droughty periods especially in dry land areas."

405	Toxic to animals	
	Source(s)	Notes
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	[Possibly under certain situations, but generally considered a valuable forage grass] "Oxalate levels can cause 'big head' (<i>Osteodystrophia fibrosa</i>) in horses, and oxalate poisoning in young or hungry sheep. However, with soluble oxalate levels of 1-2% in the DM, there is rarely a problem with mature ruminants."

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Magnaporthe (<i>Pyricularia</i>) grisea is a blast fungus that has caused dieback of <i>C. ciliaris</i> in the United States and Mexico, where the widely planted common buffel grass (cultivar T-4464) appears to be especially susceptible (Rodriguez et al., 1999). Other cultivars have shown tolerance to the fungus (Díaz-Franco and Méndez-Rodríguez, 2005). In Australia, dieback of <i>C. ciliaris</i> that seems to be associated with an unidentified pathogen has been reported (Makiela and Harrower, 2008). Injury and death of <i>C. ciliaris</i> due to feeding by spittle bugs (<i>Aeneolamia albofasciata</i> Lall.) has been observed in Mexico, especially in wet years (Martin-R et al., 1995). Around Queensland, Australia, larvae of the buffel grass seed moth (<i>Mampava rhodoneura</i> Turner) sometimes feed on seed heads (Cook et al., 2005), but they do not appear to be economically important."

Qsn #	Question	Answer
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	'Laredo' ... "Mixture of several lines. Resistant to current strains of buffel grass blight in the North America. Marketed by Pogue Agri Partners Inc."

407	Causes allergies or is otherwise toxic to humans	
	Source(s)	Notes
	Singh, A. B., & Kumar, P. 2002. Common environmental allergens causing respiratory allergy in India. The Indian Journal of Pediatrics, 69(3): 245-250	[Pollen may affect susceptible individuals] "Based on clinico-immunological studies with pollen antigens, important allergenic pollen of India have been identified" [Includes <i>Cenchrus ciliaris</i>]

408	Creates a fire hazard in natural ecosystems	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The dried shoots provide excellent fuel for fires and thus increase fire hazards. The cover of this grass may increase rapidly after a fire."

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Seedlings can tolerate ~60% shade (Pyon et al., 1977), but flowering and seed production might require more light."
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	"Intolerant of shade."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	"Often occurs in the wild on sandy soils, but is also well adapted to deep, freely draining sandy loam, loam, clay loam and red earth soils. Although slow to establish on black cracking clay soils, once established it grows well. Requires good fertility, particularly with respect to N, P and Ca. P levels should be >10 mg/kg and total N levels >0.1%. The optimum soil reaction is pH 7-8, but grows on soils with pH as low as 5.5. Very sensitive to high levels of soil aluminium and manganese. Apart from soil depth, rooting depth is also limited by high subsoil salinity or sodicity and low pH (<5). However, does have moderate tolerance of salinity, but not as good as that of <i>Chloris gayana</i> ."

Qsn #	Question	Answer
411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Perennial bunchgrass, rarely spreading..."
412	Forms dense thickets	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Where invasive, the grass forms dense mats or tussocks that displace native grassland communities and reduce their species richness."
501	Aquatic	n
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Terrestrial] "C. ciliaris prefers dry or seasonally dry environments."
502	Grass	y
	Source(s)	Notes
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/ . [Accessed 3 Feb 2015]	"Family: Poaceae (alt. Gramineae) subfamily: Panicoideae tribe: Paniceae" [Synonym: Pennisetum ciliare (L.) Link]
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	Poaceae
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Perennial [grass], sometimes short-rhizomatous and forming mats or tussocks; culms ascending, 10-150 cm tall, 1-2 mm in diameter, wiry or sometimes almost woody at base, sometimes many branched from lower or basal nodes. Sheaths keeled, glabrous or sparsely pilose; ligule a densely ciliate membrane 0.5-2.5 mm long; blades 3-25 cm long, 2-13 mm wide, glabrous or sparsely pilose, apex caudate. "
601	Evidence of substantial reproductive failure in native habitat	n

Qsn #	Question	Answer
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[No evidence] "Although limited spread of <i>C. ciliaris</i> may be observed at arid sites in dry years, unusually wet years can promote sudden and expansive seedling establishment across large areas (e.g. Burgess et al., 1991). Once established, the plants are long-lived and highly tolerant of drought. <i>C. ciliaris</i> can potentially flower in its first year of growth (facultative annual), but established plants may live for more than a decade. Seeds can remain viable in soil for at least four years (Winkworth 1971). Fresh seeds have low germination rates due to dormancy, which is typically lost over 4-16 weeks (Hacker and Ratcliff, 1989). Seeds may germinate throughout the year in response to rain. Seedlings can tolerate ~60% shade (Pyon et al., 1977), but flowering and seed production might require more light."

602	Produces viable seed	y
	Source(s)	Notes
	Weber, E. 2003. <i>Invasive Plant Species of the World. A Reference Guide to Environmental Weeds.</i> CABI Publishing, Wallingford, UK	"Caryopses are ovoid, 1.5-2 mm long and c. 1 mm in diameter." ... "Seeds are wind dispersed."
	Pacific Seed Company. 2012. <i>Laredo Buffelgrass (Pennisetum ciliaris L.).</i> Pacific International Seed Company, Inc., Walnut Creek, CA. http://www.pacificseed.com/productPDF/Laredo.pdf . [Accessed]	[Seeds of cv. 'Laredo' available for sale & cultivation] "Laredo buffelgrass is a highly nutritious grass and is considered excellent for pasture in hot, dry areas and is valued for its production of palatable forage and intermittent grazing during droughty periods especially in dry land areas. It is easy to cultivate and low cost of establishment, comparatively high value and yield, extreme drought tolerance, stand persistence, and tolerance to crop pests, overgrazing and trampling by livestock."

603	Hybridizes naturally	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Unknown] "Natural hybridization between <i>C. ciliaris</i> and <i>Pennisetum</i> species seems unlikely due to genetic incompatibilities (e.g. Marchais and Tostain 1997), but hybridization with <i>Cenchrus setigerus</i> has been reported, and hybridization between different introduced <i>C. ciliaris</i> varieties could lead to increased spread and invasiveness."

604	Self-compatible or apomictic	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>C. ciliaris</i> is apomictic, meaning that it can produce asexual seeds that are genetically identical to the mother plant; however, genetic markers indicate that sexual reproduction is also likely (Kharrat Souissi et al. 2011)."

605	Requires specialist pollinators	n
-----	---------------------------------	---

Qsn #	Question	Answer
	Source(s)	Notes
	Zomlefer, W.B. 1994. Guide to Flowering Plant Families. The University of North Carolina Press, Chapel Hill & London	"The reduced flowers are anemophilous..." [Wind-pollinated. Poaceae family description]
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[No pollination required] " <i>C. ciliaris</i> is apomictic, meaning that it can produce asexual seeds that are genetically identical to the mother plant; however, genetic markers indicate that sexual reproduction is also likely (Kharrat Souissi et al. 2011)."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Perennial [grass], sometimes short-rhizomatous and forming mats or tussocks; culms ascending, 10-150 cm tall, 1-2 mm in diameter, wiry or sometimes almost woody at base, sometimes many branched from lower or basal nodes. " [Yes for rhizomatous forms]
	Marshall, V. M., Lewis, M. M., & Ostendorf, B. 2012. Buffel grass (<i>Cenchrus ciliaris</i>) as an invader and threat to biodiversity in arid environments: a review. <i>Journal of Arid Environments</i> , 78: 1-12	"Some varieties can also reproduce vegetatively through rhizomes and stolons. The result of this is that a range of plant forms occur and can be observed growing in dense monotypic stands, as well as in small clumps or even lone tussocks throughout the landscape."
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Spread is mainly by seeds." ... " <i>C. ciliaris</i> is a fast-growing, shortly stoloniferous perennial that can flower in its first year of growth. Individual plants develop as clumps usually with only limited lateral spread, but a clump may eventually grow to >1 m in diameter."
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	[Shortly rhizomatous] "Extremely variable species, tufted (sometimes shortly rhizomatous) perennial, with types ranging in habit from ascendant to erect, and branching culms from about 0.3-2.0 m at maturity. "

607	Minimum generative time (years)	1
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>C. ciliaris</i> is a fast-growing, shortly stoloniferous perennial that can flower in its first year of growth." ... "Once established, the plants are long-lived and highly tolerant of drought. <i>C. ciliaris</i> can potentially flower in its first year of growth (facultative annual), but established plants may live for more than a decade."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes

Qsn #	Question	Answer
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"After deliberate plantings, seeds are spread by wind, water, machinery and animals (including potential for attachment to human clothing)." ... "seed-bearing fascicles have bristles that can cling externally to animals and clothing, and seeds are small (1.5-2 mm) and could be dispersed with mud on hooves or vehicles." ... "Roadside gusts associated with passing vehicles are likely to facilitate the spread of seeds along roadsides (and similarly, along railways). Roadside mowing could also facilitate spread of seeds."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>C. ciliaris</i> has been deliberately transported between most arid and semi-arid regions of the world." ... " <i>C. ciliaris</i> has been planted as a fodder and for erosion control in most warm arid and semi-arid regions of the world."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[No evidence, but may be possible if growing in proximity to other cultivated crops] " <i>C. ciliaris</i> has been deliberately transported between most arid and semi-arid regions of the world. After deliberate plantings, seeds are spread by wind, water, machinery and animals (including potential for attachment to human clothing)."

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Caryopses are ovoid, 1.5-2 mm long and c. 1 mm in diameter." ... "Seeds are wind dispersed."
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Wind may be the primary mode of dispersal over short-to-moderate distances."

705	Propagules water dispersed	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"After deliberate plantings, seeds are spread by wind, water, machinery and animals (including potential for attachment to human clothing). ' ... "Common establishment of <i>C. ciliaris</i> along drainage areas (Puckey et al. 2007) suggests water dispersal in some cases."

Qsn #	Question	Answer
706	Propagules bird dispersed	n
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	[Not fleshy-fruited. External dispersal may be possible, but probably unlikely] " <i>C. ciliaris</i> has been deliberately transported between most arid and semi-arid regions of the world. After deliberate plantings, seeds are spread by wind, water, machinery and animals (including potential for attachment to human clothing)."

707	Propagules dispersed by other animals (externally)	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"seed-bearing fascicles have bristles that can cling externally to animals and clothing, and seeds are small (1.5-2 mm) and could be dispersed with mud on hooves or vehicles. Ants can also disperse <i>C. ciliaris</i> seeds (Goldsmith et al., 2008)."

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"One study found that seeds ingested by cattle remained intact but failed to germinate (Gardener et al., 1993), suggesting that internal dispersal by animals may be limited"

801	Prolific seed production (>1000/m ²)	n
	Source(s)	Notes
	Hacker, J. B. 1989. The potential for buffel grass renewal from seed in 16-year-old buffel grass-siratro pastures in south-east Queensland. <i>Journal of Applied Ecology</i> 26(1): 213-222	[<60 seeds/m ²] "Soil reserves of buffel grass seeds were < 60 m ⁻² despite 490-2300 fascicles m ⁻² . Large numbers of rotten seeds were found"

802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Seeds can remain viable in soil for at least four years (Winkworth 1971)."
	Marshall, V. M., Lewis, M. M., & Ostendorf, B. 2012. Buffel grass (<i>Cenchrus ciliaris</i>) as an invader and threat to biodiversity in arid environments: a review. <i>Journal of Arid Environments</i> , 78: 1-12	"Seeds may lay dormant in the ground for up to 8 months, while retaining the original seed viability (Winkworth, 1963). Beyond 12 months, germination rates drop to less than 12%, and remain at 10% for around a two years after that (Winkworth, 1963b)."

803	Well controlled by herbicides	y
	Source(s)	Notes

Qsn #	Question	Answer
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	"Can be controlled using a combination of glyphosate and ammonium sulphate, possibly in repeat applications. Seedlings can be controlled using the grass -selective herbicide, fluazifop-p-butyl or dicamba, 2,4-D, 3,6-dichloropicolinic acid, triclopyr, tebuthiuron, or hexazinone. Older stands, particularly freshly cut material can be at least reduced using hexazinone or tebuthiuron."
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Dixon et al. (2002) found that glyphosate effectively killed <i>C. ciliaris</i> and haloxyfop was successfully used to kill seedlings and as a grass-specific pre-emergent herbicide to prevent recolonization. Daehler and Goergen (2005) also found that glyphosate effectively killed established <i>C. ciliaris</i> . At higher concentrations, fluazifop-p, a grass-specific herbicide, was also effective at killing <i>C. ciliaris</i> (Dixon et al., 2002). In all cases, plants need to be actively growing at the time of initial herbicide application. Dixon et al. (2002) found that an ideal timing for herbicide application exists a few weeks after rain, when established plants are actively growing and new seedlings have also germinated. Control rates were approximately 98% across an area of several hectares. Control sites need to be monitored for several years following seasonal rains, as seedlings will continue to emerge from the seed bank."
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching, L. 2003. Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide. CTAHR, UH Manoa, Honolulu, HI	"Sensitive to glyphosate. Preemergence and postemergence control by drizzle application of hexazinone effective"

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	Notes
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Once <i>C. ciliaris</i> has become established in an area, manual removal (by digging) has sometimes been effective for small areas (e.g. Daehler and Goergen 2005), but manual removal is very labour intensive and plants can grow back from small rhizome pieces left in the soil." ... "Mowing is not effective in reducing <i>C. ciliaris</i> invasion, and may help disperse the species if the mown plants have inflorescences. On the other hand, mowing or grazing may be helpful in reducing fire risks as part of an integrated management plan."
	Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., & Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], SIRO, DPI&F(Qld), CIAT and ILRI. http://www.tropicalforages.info/index.htm . [Accessed 3 Feb 2015]	"Very tolerant of regular cutting or grazing." ... "Very tolerant of, and favoured by fire. Cover of <i>Cenchrus ciliaris</i> can increase, and populations of associated fire-susceptible species decrease in a fire regime."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	n
	Source(s)	Notes

Qsn #	Question	Answer
	CABI. 2015. <i>Cenchrus ciliaris</i> In: Invasive Species Compendium. www.cabi.org/isc	"Classical biocontrol is unlikely to be an option because of actual and/or perceived benefits of <i>C. ciliaris</i> , and also because classical biocontrol of grasses has generally proven difficult. However, use of grazers to manage the species could be an option for reducing its dominance (and fuel load) in some areas (Friedel et al., 2011)."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Widespread distribution in Hawaiian Islands suggests no effective natural enemies exist] ["Native to Africa and tropical Asia, naturalized elsewhere in the Old World; in Hawaii naturalized and common in dry areas and sandy soil in a wide variety of disturbed habitats, 0-120 m, on all of the main islands except Niihau."]

Summary of Risk Traits:

High Risk / Undesirable Traits

- Broad climate suitability, demonstrating environmental versatility
- Thrives in tropical climates
- Widely naturalized
- Environmental weed (reduces biodiversity)
- Other *Cenchrus* species have become invasive
- Potentially allelopathic
- Possibly allergenic to susceptible people
- Increases fire risk in natural environment
- Tolerates many soil types
- Forms dense mats & ground cover
- Produces seeds apomictically
- Able to reach maturity in one growing season
- Seeds dispersed by wind, through attachment to animals & equipment & intentionally by people
- Seeds forms a persistent seed bank
- Tolerates grazing, mowing & fire

Low Risk Traits

- Unarmed (no spines, thorns or burrs)
- Palatable to grazing animals
- Relatively shade intolerant
- Herbicides may provide effective control