

<b>Taxon:</b> <i>Medicago sativa</i> L.	<b>Family:</b> Fabaceae
<b>Common Name(s):</b> alfalfa lucerne violet-flower lucerne	<b>Synonym(s):</b> <i>Medicago caerulea</i> var. <i>pauciflora</i> <i>Medicago karatschaica</i> Latsch. <i>Medicago lavrenkoi</i> Vassilcz. <i>Medicago pauciflora</i> Ledeb. <i>Medicago sativa</i> var. <i>pilifera</i> Urb.

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 22 Feb 2019
<b>WRA Score:</b> 12.0	<b>Designation:</b> H(HPWRA)	<b>Rating:</b> High Risk

**Keywords:** Perennial Herb, Naturalized, Fodder, N-Fixing, Animal-Dispersed

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

Qsn #	Question	Answer Option	Answer
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	n
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	n
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic		
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	1
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	y
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed		
706	Propagules bird dispersed	y=1, n=-1	y
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m <sup>2</sup> )		
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?	y
	Source(s)	Notes
	Muller, M. H., Poncet, C., Prospero, J. M., Santoni, S., & Ronfort, J. (2006). Domestication history in the <i>Medicago sativa</i> species complex: inferences from nuclear sequence polymorphism. <i>Molecular Ecology</i> , 15(6), 1589-1602	"Alfalfa ( <i>Medicago sativa</i> ssp. <i>sativa</i> ) is a perennial, outcrossing, autotetraploid crop cultivated as forage. It belongs to a species complex ( <i>M. sativa</i> L.) that includes diploid and tetraploid interfertile subspecies (Lesins & Lesins 1979). Alfalfa was domesticated presumably in the Near East (Iran, plain of Mesopotamia) and/or in Central Asia around 5000 bc. Its cultivation was then introduced to Asia, and twice in the Mediterranean basin first with the Roman Empire and then with the Moors (Michaud et al. 1988). Today, feral populations of alfalfa (i.e. domesticated plants growing outside fields) are common in all areas of cultivation."

102	Has the species become naturalized where grown?	y
	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 20 Feb 2019]	"Naturalized Africa MACARONESIA: Portugal [Azores] NORTHERN AFRICA: Egypt SOUTHERN AFRICA: South Africa Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Sri Lanka Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Europe NORTHERN EUROPE: Finland Northern America United States Southern America BRAZIL: Brazil (s.) WESTERN SOUTH AMERICA: Ecuador, Peru SOUTHERN SOUTH AMERICA: Argentina, Chile, Uruguay (s.)"
	Muller, M. H., Poncet, C., Prospero, J. M., Santoni, S., & Ronfort, J. (2006). Domestication history in the <i>Medicago sativa</i> species complex: inferences from nuclear sequence polymorphism. <i>Molecular Ecology</i> , 15(6), 1589-1602	"Today, feral populations of alfalfa (i.e. domesticated plants growing outside fields) are common in all areas of cultivation."

103	Does the species have weedy races?	y
	Source(s)	Notes
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 20 Feb 2019]	"As a hardy perennial plant, alfalfa can survive the winter and potentially persist in following crops as a volunteer weed. In Manitoba, where 652,000 hectares of alfalfa/alfalfa mixtures are grown (Statistics Canada, 2002), volunteer alfalfa was reported to be the 29th most abundant weed in agricultural fields in that province (Thomas et al. 1997) indicating this plant is present as a weed in agricultural systems but that it is of limited significance."

Qsn #	Question	Answer
	White, M. R. (ed.). 2013. Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region. Second Edition. USDA Forest Service, Southwestern Region, Apache-Sitgreaves National Forests	"Native to southwest Asia; deep rooting habit (where possible as much as 20 feet or more) makes alfalfa a very drought resistant plant. Alfalfa has been cultivated for forage worldwide. Alfalfa may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. This species generally occurs as a weed in wildland areas of the Southwestern Region rather than as an invasive plant."

201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	Intermediate
	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 20 Feb 2019]	"Native Africa NORTHERN AFRICA: Algeria, Libya, Morocco, Tunisia Asia-Temperate WESTERN ASIA: Afghanistan, Cyprus, Iran, Iraq, Israel (rare), Jordan, Lebanon, Syria, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia SIBERIA: Russian Federation-Eastern Siberia, [Eastern Siberia] Russian Federation-Western Siberia [Western Siberia] MIDDLE ASIA: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan MONGOLIA: Mongolia RUSSIAN FAR EAST: Russian Federation-Far East [Far East] CHINA: China (n.) EASTERN ASIA: Korea Asia-Tropical INDIAN SUBCONTINENT: Pakistan Europe NORTHERN EUROPE: Denmark, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium, Czechoslovakia, Germany, Hungary, Netherlands, Poland, Switzerland EASTERN EUROPE: Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation-European part, [European part] Ukraine (incl. Krym) SOUTHEASTERN EUROPE: Albania, Bulgaria, Former Yugoslavia, Greece, Italy, Romania SOUTHWESTERN EUROPE: France, Portugal, Spain"

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 20 Feb 2019]	

203	Broad climate suitability (environmental versatility)	y

Qsn #	Question	Answer
	Source(s)	Notes
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 20 Feb 2019]	"Alfalfa is adapted to a range of climatic and soil conditions, but prefers deep loam soils that are not acidic (pH 6.5). Soils with good drainage are essential for alfalfa growth and crop persistence." ... "Alfalfa is a plant species that is well adapted to most environments as evidenced by its worldwide distribution. Characteristics of the plant that aid adaptation are, the perennial growth habit, ability to survive winter temperatures as low as -20°C (McKenzie et al., 1988), production of hard seed and nitrogen-fixing (legume) symbiosis. These characteristics also facilitate survival outside of cultivation."
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 20 Feb 2019]	"Alfalfa shows considerable variation in form and adaptation to environment. Form of plant varies from erect to decumbent from southern subtropical areas to northern temperate regions and from lower to higher elevations. Length of vegetation period decreases from south to north and from lower to higher elevations. Many strains are adapted to different climatic plains as in hilly regions, up to an altitude of about 2400 m (to 4000 in Boliva); can withstand high temperatures of 39–41°C as well as rather low temperatures, the degree of adaptability varying with different strains. Thrives particularly well in semi-arid regions under irrigation. Some clones that are self-sterile at low temperatures may be partially self-fertile at high temperatures. Annual rainfall of 5–6 dm is optimum (in the temperature zone), but crop will survive less. Soil moisture can be reduced to 35% of the water holding capacity of a soil before affecting photosynthesis. In areas of high rainfall of 10 dm or more, alfalfa does not grow well as a perennial. "
	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.	[Elevation range exceeds 2000 m, demonstrating environmental versatility] "in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3-2,075 m"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30	"Known from Midway Atoll, Kaua'i, O'ahu, Lāna'i, East & West Maui, and Hawai'i (Wagner et al., 1990: 686; Wagner & Herbst, 1995: 20; Wagner et al., 1997: 57; Oppenheimer et al., 1999: 8), <i>M. sativa</i> was recently collected on Moloka'i."
	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.	[Found in a broad range of elevations] "in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3- 2,075 m, on Midway Atoll, Kaua'i, O'ahu, Lana'i, and Hawai'i."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes

Qsn #	Question	Answer
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 20 Feb 2019]	"Alfalfa originated in southwestern Asia, was first cultivated in Iran, and now has a worldwide distribution due to its popularity as an agricultural species. It was introduced into the United States in 1736 in Georgia, but it was not until around 1850 that it began to be more widely planted. It is planted in all 50 states and is widely planted in Canada. It is naturalized in many areas"
	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 Europe, cultivated as a fodder plant and widely naturalized"

301	Naturalized beyond native range	y
	Source(s)	Notes
	Oppenheimer, H. L., Meidell, J. S., Bartlett, R. T. 1999. New plant records for Maui and Moloka'i. Bishop Museum Occasional Papers. 59: 7-11	"According to Wagner et al. (1990: 686), this species was known to be naturalized on Midway Atoll, Kaua'i, O'ahu, Lana'i and Hawai'i. Wagner & Herbst (in Evenhuis & Miller, 1995b: 20) later reported its occurrence on Maui, citing a collection by Hobdy (Hobdy et al. 3381 BISH), from a roadside near Hali'imaile on East Maui. Wagner et al. (in Evenhuis & Miller, 1997a: 57) again cited this specimen, as well as a collection by Medeiros (Medeiros 295, BISH). The following collections document a range extension to West Maui. Material examined. MAUI: West Maui, Lahaina District, Growing in lawn at the Maui County Mahinahina Water Treatment Facility, 214 m, 27 Jul 1998, Oppenheimer H79804A; 9 Sep 1998, Oppenheimer H79804B."
	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.	"in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3-2,075 m, on Midway Atoll, Kaua'i, O'ahu, Lana'i, and Hawai'i. Introduced probably in the early 1900s (Degener 34, BISH); first collected on Lana'i in 1929 (Munro 491, BISH)."
	Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30	"Known from Midway Atoll, Kaua'i, O'ahu, Lana'i, East & West Maui, and Hawai'i (Wagner et al., 1990: 686; Wagner & Herbst, 1995: 20; Wagner et al., 1997: 57; Oppenheimer et al., 1999: 8), <i>M. sativa</i> was recently collected on Moloka'i. Material examined: MOLOKA'I: Vicinity of Kapu'aiwa coconut grove, roadside weed, 3 m, 18 Nov 2001, Oppenheimer H110148."
	Wagner, W.L., Shannon, R.K. & Herbst, D.R. 1997. Contributions to the Flora of the Hawai'i. VI. Bishop Museum Occasional Papers 48: 51-65	" <i>Medicago sativa</i> L. New island record Formerly known to occur on Midway Atoll, Kaua'i, O'ahu, Lana'i, and Hawai'i (Geesink et al., 1990: 686), <i>Medicago sativa</i> is now known to occur on Maui as well. Material examined. MAUI: [East Maui?], roadside hale, 2160 m, 30 Oct. 1982, Medeiros 295 (BISH); East Maui, Baldwin Ave. near Hali'i Maile Rd. jct, weed on road shoulder, 17 June 1991, Hobdy et al. 3381 (BISH)."
	Wagner, W.L. & Herbst, D.R. (1995). Contributions to the flora of Hawaii. IV. New records and name changes. Bishop Museum Occasional Paper 42: 13-27	" <i>Medicago sativa</i> L. The following collection represents a new island record from Maui for <i>Medicago sativa</i> . This species was previously known to be naturalized on Midway Atoll, Oahu, Lanai, and Hawaii. Material examined. Maui: East Maui, Baldwin area near Halliimaile Rd. junction, a weed on road shoulder, 17 Jun 1991, Hobdy et al. 3381 (BISH)."

Qsn #	Question	Answer
	<p>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 20 Feb 2019]</p>	<p>"Naturalized Africa MACARONESIA: Portugal [Azores] NORTHERN AFRICA: Egypt SOUTHERN AFRICA: South Africa Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Sri Lanka Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Europe NORTHERN EUROPE: Finland Northern America United States Southern America BRAZIL: Brazil (s.) WESTERN SOUTH AMERICA: Ecuador, Peru SOUTHERN SOUTH AMERICA: Argentina, Chile, Uruguay (s.)"</p>

302	Garden/amenity/disturbance weed	y
	Source(s)	Notes
	<p>Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., &amp; Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA</p>	<p>"Despite the occurrence of feral alfalfa and its 200-year history in North America, it is not considered weedy, noxious, or invasive in cultivated or feral settings (CFIA 2005)."</p>
	<p>Duke, J. A. (1983). <i>Medicago sativa</i>. Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a>. [Accessed 22 Feb 2019]</p>	<p>"The cultivated forms probably arose in western Persia and then spread, to become widely cultivated, often a "weed" throughout Asia, Europe, and America."</p>
	<p>Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall</p>	<p>"Weed of: Cereals, Grapevines, Orchards &amp; Plantations, Pastures, Vegetables"</p>
	<p>Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a>. [Accessed 21 Feb 2019]</p>	<p>"While alfalfa is a highly adaptable plant species, <i>M. sativa</i> is not listed as a noxious weed in the Weed Seeds Order (1986). In managed ecosystems, alfalfa does not effectively compete with cultivated plants, nor is it recorded as being invasive of natural ecosystems. There is no evidence in Canada that <i>M. sativa</i> has weed or pest characteristics."</p>
	<p>WRA Specialist. (2019). Personal Communication</p>	<p>A generally desirable plant, but often identified as a weed of disturbed habitats or other crops. Conservatively identified here as a general weed with potential impacts to agriculture</p>

303	Agricultural/forestry/horticultural weed	
	Source(s)	Notes
	<p>Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., &amp; Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA</p>	<p>"Despite the occurrence of feral alfalfa and its 200-year history in North America, it is not considered weedy, noxious, or invasive in cultivated or feral settings (CFIA 2005)."</p>

Qsn #	Question	Answer
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Grapevines, Orchards & Plantations, Pastures, Vegetables"
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 22 Feb 2019]	"While alfalfa is a highly adaptable plant species, <i>M. sativa</i> is not listed as a noxious weed in the Weed Seeds Order (1986). In managed ecosystems, alfalfa does not effectively compete with cultivated plants, nor is it recorded as being invasive of natural ecosystems. There is no evidence in Canada that <i>M. sativa</i> has weed or pest characteristics."

304	Environmental weed	n
	Source(s)	Notes
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Despite the occurrence of feral alfalfa and its 200-year history in North America, it is not considered weedy, noxious, or invasive in cultivated or feral settings (CFIA 2005)."
	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.	"in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3- 2,075 m" [Disturbed habitat. Not reported to impact natural areas]
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 21 Feb 2019]	"While alfalfa is a highly adaptable plant species, <i>M. sativa</i> is not listed as a noxious weed in the Weed Seeds Order (1986). In managed ecosystems, alfalfa does not effectively compete with cultivated plants, nor is it recorded as being invasive of natural ecosystems. There is no evidence in Canada that <i>M. sativa</i> has weed or pest characteristics."

305	Congeneric weed	y
	Source(s)	Notes
	CABI. (2019). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	" <i>Medicago polymorpha</i> is a herbaceous legume that is native to western and central Asia and countries around the Mediterranean, and has been introduced widely around the world. It is found in particular in regions with a Mediterranean climate, but is by no means confined to them. Introduction has been a result of accidental transport of the spiny seed pods and probably also of deliberate introduction as a fodder plant; the relative importance of these two means of spread cannot be determined. The species can be a useful pasture plant, in particular because of its nitrogen-fixing ability, but in other places it is considered to be an invasive weed; it can sometimes be toxic to livestock, and the seed pods can be a serious contaminant of wool."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	A number of <i>Medicago</i> species are listed as naturalized and/or weeds

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



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.	[No evidence] "Erect perennial herbs, with a deep taproot and a short-branched superficial caudex; stems 3-10 dm long, sometimes with decumbent branches, pubescent to glabrous. Leaflets narrowly obovate to linear-elliptic, (8-)15-35 mm long, (3-)5-15 mm wide, pubescent, stipules narrowly ovate to linear, apex of stipules dentate. Flowers 5- 40 in racemes; corolla violet purple, (5-)6- 11 mm long. Pods curved or spirally twisted in 1-1.5(-3) complete turns, 4-7 mm in diameter, transverse veins forming a distinct but not very prominent transverse or radially elongated network, prickles absent."

402	Allelopathic	y
	Source(s)	Notes
	Koloren, O. (2007). Allelopathic Effects of <i>Medicago sativa</i> L. and <i>Jicia cracca</i> L. Pakistan Journal of Biological Sciences, 10(10), 1639-1642	"Abstract: In this study, the allelopathic potential of different concentration (5, 25 and 50%) of <i>M. sativa</i> and <i>V. cracca</i> leaf and root extracts were evaluated on germination and radicle length of four weed species ( <i>Amaranthus retroflexus</i> L., <i>Lolium perenne</i> L., <i>Ipomoea hederacea</i> L. and <i>Portulaca oleracea</i> L.) in laboratory condition. As a result, germination and radicle length of all species were reduced by the extract from <i>M. sativa</i> and <i>V. cracca</i> leaf and root at different percentage. Increasing the water extract concentrations from 5 to 50% of test plants parts significantly increased the inhibition of all weed species germination and radicle length."
	Abdul-Rahman, A. A., & Habib, S. A. (1989). Allelopathic effect of alfalfa ( <i>Medicago sativa</i> ) on bladygrass ( <i>Imperata cylindrica</i> ). Journal of Chemical Ecology, 15(9), 2289-2300	"Greenhouse and laboratory experiments were conducted at the Agricultural and Water Resources Research Center Station, Baghdad, in 1985 and 1986 to investigate the possible allelopathic potential of alfalfa ( <i>Medicago saliva</i> L.) and its decomposed residues on bladygrass ( <i>Imperata cylindrica</i> L. Beauv.), a noxious weed in Iraq, and to isolate, characterize, and quantify possible allelopathic agents in alfalfa residues and root exudates. Results indicated that decomposed alfalfa roots and their associated soil produced a 51–56% reduction in bladygrass seed germination. Root and shoot length of bladygrass seedlings were reduced by an average of 88%. Decayed and undecayed mixtures of alfalfa roots and soil at 0.015–1 (w/w) inhibited bladygrass seedlings reproduced from rhizomes by 30 and 42%. It was found that root exudates of alfalfa seedlings caused significant reduction in shoot and root dry weights of bladygrass seedlings when alfalfa and bladygrass were grown together in nutrient culture. Caffeic, chlorogenic, isochloro-genic, p-coumaric, p-OH-benzoic, and ferulic acids were detected in alfalfa root exudates and residues. The highest amount (126 fig phenolic acids/g soil) of these compounds was found in alfalfa root residues after six months of decomposition in soil."

Qsn #	Question	Answer
403	Parasitic	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.	"Erect perennial herbs, with a deep taproot and a short-branched superficial caudex;" [Fabaceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 20 Feb 2019]	"IMPORTANCE TO LIVESTOCK AND WILDLIFE : Alfalfa is consumed by most herbivores and omnivores, including all classes of livestock and big game animals. It is valued for rehabilitation of overgrazed ranges in part because it begins growth early and retains green succulence later than grasses [111]. Graham [45] reported that 27 species of birds and 46 species of mammals are known to use alfalfa. Birds utilizing the leaves, flowers, or seeds include sage grouse, sharptailed grouse, pheasant, California quail, gray partridge, American wigeon, mallard, and little brown crane [88,104,111]. Alfalfa is consumed by juvenile prairie chickens in summer, composing up to 7 percent of crop volume [101]."
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 20 Feb 2019]	"Valued as a forage crop due to its high feeding value and wide adaptability, alfalfa is an important rotational crop, providing soil structure, nitrogen contribution, and pest management benefits."

405	Toxic to animals	
	Source(s)	Notes
	Burrows, G. E., & Tyrl, R. J. (2013). Toxic Plants of North America. Second Edition. Wiley-Blackwell, Hoboken, NJ	[May cause problems in certain situations] "Although one of the most important forage crops because of its productivity and nitrogen content, <i>M. sativa</i> is associated with four very different disease problems. Two —bloat and ARDS —are of primary importance. Of lesser importance are photosensitization and estrogenic effects."
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 20 Feb 2019]	[ <i>Medicago sativa</i> generally regarded as palatable and not toxic] "The genus <i>Medicago</i> has been reported to contain the following chemicals, relative toxicities of which are tabulated in Duke's "Phytotoxin Tables" (Duke, 1981b): choline, citric acid, hydrocyanic acid, limonene, malic acid, malonic acid, oxalic acid, pantothenic acid, pectin, quinic acid, saponin, shikimic acid, tannin, trigonelline, and tryptophane. Four isoflavones are reported in alfalfa (daidzein, formononetin, genistein, and biochanin A) and they, like coumestrol, produce an estrogen-like response, perhaps contributing to reproductive disturbances of cattle on high-estrogen forage. Seeds are reported to contain trypsin inhibitors. Some people are allergic to the dust generated when milling alfalfa."

406	Host for recognized pests and pathogens	
	Source(s)	Notes

Qsn #	Question	Answer
	<p>Sullivan, J. 1992. <i>Medicago sativa</i>. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.  <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a>. [Accessed 22 Feb 2019]</p>	<p>"Insect pests: The pea aphid (<i>Acyrtosiphon pisum</i>) causes stunted, wilted plants and reduces cold hardiness. The alfalfa weevil (<i>Hypera postica</i>) is the most important pest in the United States and Ontario. It can defoliate both first and second cuttings of hay, reducing hay yield up to 50 percent and also reducing hay quality. Alfalfa curculio (<i>Sitona scissifrons</i>), a weevil that attacks leaf edges, is not a problem in established stands but can destroy seedling fields. Lygus plant bugs (<i>Lygus</i> spp.) mostly damage seed production. The alfalfa looper (<i>Autographa californica</i>) is not a serious problem except where local outbreaks can cause severe damage. Grasshoppers (<i>Melanoplus</i> spp., <i>Camnula</i> spp.) consume all plant parts and can be extremely destructive in dry years [110]." ... "Diseases: Most diseases of alfalfa become more severe with the age of the stand; most stands are free of disease the first year, with the exception of alfalfa sickness. Disease can be established by the second year, and by the fourth year, it is often uneconomical to maintain the stand. Stands can be kept healthy by such management practices as adequate fertilizer and water. Varieties should be chosen that are resistant to diseases common to the area. Leaf and stem diseases include common leaf spot, yellow leaf blotch, black stem, downy mildew, and verticillium wilt. Crown and root diseases include winter crown rot crown bud rot, bacterial wilt, alfalfa sickness, and brown root rot [110]."</p>
	<p>Duke, J. A. (1983). <i>Medicago sativa</i>. Handbook of Energy Crops.  <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a>. [Accessed 22 Feb 2019]</p>	<p>"Over 100 species of fungi have been reported to cause diseases on alfalfa. Among the most serious are the following: <i>Colletotrichum trifolii</i>, (anthracnose), <i>Pseudopeziza medicaginis</i>, <i>P. jonesii</i>, <i>Leptosphaerulina briosiana</i>, <i>Stemphylium</i> spp., <i>Uromyces striatus</i> (rust), <i>Peronospora trifoliorum</i> (downy mildew), <i>Phoma medicaginis</i> (spring black stem and leafspot), <i>Ascochyta imperfecta</i> (leafspot), <i>Sclerotinia trifoliorum</i> (stem rot), <i>Fusarium</i> spp., and <i>Phytophthora megasperma</i> (root rot). Bacterial wilt, caused by <i>Corynebacterium insidiosum</i>, is one of the most destructive alfalfa diseases. Virus diseases include: Alfalfa mosaic, Lucerne mosaic, Yellow-green stripe mosaic, Rugose leaf-curl and Witches broom virus of lucerne. Parasitic plants attacking alfalfa include: <i>Orobanche lutea</i>, <i>Cuscuta australis</i>, <i>C. arvensis</i>, <i>C. campestris</i>, <i>C. chinensis</i>, <i>C. epithimum</i>, <i>C. gronovii</i>, <i>C. indecora</i>, <i>C. pentagona</i>, <i>C. planiflora</i>, <i>C. racemosa</i>, <i>C. suaveolens</i>, and <i>C. trifolia</i>.. Nematodes attacking alfalfa are numerous and belong to several genera. Some are found in the roots, while others are only found in the soil near the roots. Stem nematodes (<i>Ditylenchus dipsaci</i>) and root-knot nematodes (<i>Meloidogyne</i> spp.) cause much damage; the cultivars, 'Lahontan' and 'Washoe' are resistant to stem nematodes. Among important insect pests of alfalfa are the following: alfalfa weevil (<i>Hypera postica</i>), to which there are some resistant cultivars; spotted alfalfa aphid (<i>Therioaphis maculata</i>), and pea aphid (<i>Acyrtosiphon pisum</i>), to both of which there are resistant cultivars; Potato leafhopper causing alfalfa yellows (<i>Empoasca fabae</i>) and meadow spittlebug (<i>Philaenus spumarius</i>). Lygus bugs, seed chalcids and alfalfa weevils are most harmful to seed production."</p>

407	Causes allergies or is otherwise toxic to humans	
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Medicinal uses] "Used in Ayurveda and Unani. Leaves antibacterial, tonic, antiscorbutic, diuretic, emetic, febrifuge; fresh leaves eaten as a vegetable for kidney stone. Flowers used for chest pain and troubles."
	Plants for a Future. (2019). <i>Medicago sativa</i> . <a href="https://pfaf.org/user/plant.aspx?LatinName=Medicago+sativa">https://pfaf.org/user/plant.aspx?LatinName=Medicago+sativa</a> . [Accessed 22 Feb 2019]	[Possibly, if consumed in large quantities] "The plant contains saponin-like substances[222]. Eating large quantities of the leaves may cause the breakdown of red blood cells[222]. However, although they are potentially harmful, saponins are poorly absorbed by the human body and so most pass through without harm."

408	Creates a fire hazard in natural ecosystems	n
	<b>Source(s)</b>	<b>Notes</b>
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 22 Feb 2019]	[Not implicated in increased fire risk, but may occur in habitats that burn seasonally] "Alfalfa can remain green throughout the summer, and dies back in the fall with heavy frost." ... "As a perennial with a narrow root crown, alfalfa will survive most fires by sprouting after being top-killed. Alfalfa hard seeds may be scarified by moderate-severity fires [126,91]."

409	Is a shade tolerant plant at some stage of its life cycle	n
	<b>Source(s)</b>	<b>Notes</b>
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 22 Feb 2019]	"Alfalfa is probably not shade tolerant. In a study of alfalfa planted on chained aspen parklands, alfalfa cover decreased steadily as overstory canopy increased [7]."
	Plants for a Future. (2019). <i>Medicago sativa</i> . <a href="https://pfaf.org/user/plant.aspx?LatinName=Medicago+sativa">https://pfaf.org/user/plant.aspx?LatinName=Medicago+sativa</a> . [Accessed 22 Feb 2019]	"It cannot grow in the shade."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	<b>Source(s)</b>	<b>Notes</b>
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 22 Feb 2019]	"Alfalfa is adapted to a range of climatic and soil conditions, but prefers deep loam soils that are not acidic (pH 6.5)."
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 22 Feb 2019]	"Grows on a variety of soils, but thrives on rich, friable, well-drained loamy soil with loose topsoil supplied with lime; does not tolerate waterlogging and fails to grow on acid soils. Alfalfa may be a bit more tolerant of frost and salt than wheat. Salinities of 3 mmhos reduce yields by 10%, 5 mmhos by 25%, and 8 mmhos by 50%. Deep penetrating roots make alfalfa quite drought resistant."

411	Climbing or smothering growth habit	n
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Erect perennial herbs, with a deep taproot and a short-branched superficial caudex;"

412	Forms dense thickets	n
	<b>Source(s)</b>	<b>Notes</b>
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Despite the occurrence of feral alfalfa and its 200-year history in North America, it is not considered weedy, noxious, or invasive in cultivated or feral settings (CFIA 2005)." [No evidence]
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 21 Feb 2019]	[Artificially cultivated in dense stands] "In dense stands; nectar production, insect visitation and, subsequently, seed production often are depressed."

501	Aquatic	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	[Terrestrial herb] "Erect perennial herbs" ... "in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3- 2,075 m"

502	Grass	n
	<b>Source(s)</b>	<b>Notes</b>
	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 20 Feb 2019]	Family: Fabaceae (alt.Leguminosae) Subfamily: Faboideae Tribe: Trifolieae

503	Nitrogen fixing woody plant	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Erect perennial herbs, with a deep taproot and a short-branched superficial caudex;" [N-fixing herb that sometimes becomes woody]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Erect perennial herbs, with a deep taproot and a short-branched superficial caudex" [No bulbs, corms or tubers, but may persist from taproot]

Qsn #	Question	Answer
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Rhodes, L. 2016. <i>Medicago sativa</i> . The IUCN Red List of Threatened Species 2016: e.T174725A19402449. <a href="http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T174725A19402449.en">http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T174725A19402449.en</a> . [Accessed 20 Feb 2019]	"This species is globally assessed as Least Concern as its wild subspecies are widespread across Eurasia with no major threats and stable populations. They are also well conserved in ex situ gene bank collections. This species would benefit from a gap analysis to ensure that the likely range of in situ genetic diversity is fully represented in gene bank collections."

602	Produces viable seed	y
	Source(s)	Notes
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 20 Feb 2019]	"Characteristics of the plant that aid adaptation are, the perennial growth habit, ability to survive winter temperatures as low as -20°C (McKenzie et al., 1988), production of hard seed and nitrogen-fixing (legume) symbiosis. These characteristics also facilitate survival outside of cultivation."
	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.	"Pods curved or spirally twisted in 1-1.5(-3) complete turns, 4-7 mm in diameter, transverse veins forming a distinct but not very prominent transverse or radially elongated network, prickles absent. Seeds several."
	White, M. R. (ed.). 2013. Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region. Second Edition. USDA Forest Service, Southwestern Region, Apache-Sitgreaves National Forests	"Propagation/Phenology - Reproduces by seed."

Qsn #	Question	Answer
603	Hybridizes naturally	
	Source(s)	Notes
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	" <i>Medicago sativa</i> readily hybridizes with Siberian alfalfa ( <i>Medicago falcata</i> ). The intermediate form, variegated alfalfa, is named <i>Medicago sativa media</i> [37]. Some authors consider the hybrid a separate species, <i>Medicago media</i> [50,110,113]. An alternatively used name for the hybrid is <i>Medicago x varia</i> Martyn, or <i>M. s. subsp. x varia</i> (Martyn) Arcang. [100,129]."
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 21 Feb 2019]	[Artificial hybrids created. Naturally occurring hybrids unlikely to occur, but may be possible] "Because annual x perennial hybrids cannot be produced artificially, and no evidence exists for their occurrence in nature, naturally hybridization to the annual species is not discussed further in this document. Although one report of a hybrid was published (Sangduen et al., 1982), it did not produce seed, no further research on the hybrid was reported, and the experiment has never been repeated. <i>M. sativa</i> . is the only cultivated perennial species in the genus. The <i>M. sativa</i> complex has been successfully hybridized via pollination with 12 other perennial species (McCoy and Bingham, 1988), summarized in Table I and by Quiros and Bauchan [1988 (see Table 3-6 in reference)]. However, many of these interspecific hybrids have only been successful by using embryo rescue culture of the hybrid or other extraordinary procedures (McCoy and Smith, 1986) making them highly unlikely to occur in nature."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 21 Feb 2019]	"Some clones that are self-sterile at low temperatures may be partially self-fertile at high temperatures."
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 21 Feb 2019]	[Mostly self-incompatible, but self-fertile varieties may exist] "Many alfalfa plants exhibit various forms of genetic self-incompatibility or self-sterility and will not successfully self-pollinate (Viands et al., 1988). Alfalfa is adversely affected by inbreeding, i.e., self-fertilized plants commonly demonstrate a dramatic reduction in forage and seed yield potential (Rumbaugh et al., 1988). Inbreeding depression may be due to the loss of heterosis and/or accumulation and unmasking of deleterious recessive alleles that occur as a result of self-pollination and/or pollination among close relatives."

605	Requires specialist pollinators	n
	Source(s)	Notes

Qsn #	Question	Answer
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 21 Feb 2019]	"A relatively small number of bee species can effectively pollinate alfalfa flowers. Predominant species that are important for alfalfa seed production include leafcutter bees ( <i>Megachile rotunda</i> ), honeybees ( <i>Apis mellifera</i> ) and alkali bees ( <i>Nomia melanderi</i> ). In alfalfa, the leafcutter bee is the preferred pollinator due to high proficiency, in situations where alfalfa seed is being produced for commercial purposes. Leafcutter bees are purposely stocked into the seed producing alfalfa fields."
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	"Alfalfa is obligately insect pollinated. Bees are the major insect pollinators of alfalfa. Leafcutter bees ( <i>Megachile rotundata</i> ) and alkali bees ( <i>Nomia melanderi</i> ) are efficient pollinators. Honeybees ( <i>Apis mellifera</i> ) also visit alfalfa flowers but are not as efficient for pollination [50]."
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 22 Feb 2019]	"Nearly all alfalfas require the flowers to be tripped for pollination to take place; this amounts to release of the sexual column from the keel of the flower. Many types of bees can serve as trippers, e.g. the alfalfa leaf-cutter bee ( <i>Megachile rotundata</i> ), alkali bee ( <i>Nomia melandri</i> ), honeybees ( <i>Apis mellifera</i> ), and bumblebees. In North America, alfalfa-pollinating genera, listed with the number of effective species, are as follows: <i>Apis</i> (1), <i>Bombus</i> (7), <i>Xylocopa</i> (1), <i>Anthophora</i> (1), <i>Tetralonia</i> (1), <i>Osmia</i> (2), <i>Megachile</i> (10), <i>Hoplitis</i> (1), <i>Nomia</i> (1), <i>Agapostemon</i> (2), <i>Halictus</i> (3), <i>Evylaeus</i> (1), <i>Lasioglossum</i> (1), <i>Andrena</i> (2), <i>Calliopsis</i> (1)."

606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes
	Canadian Food Inspection Agency. (2012). The Biology of <i>Medicago sativa</i> L. (Alfalfa). Biology Document Bio2005-02. <a href="http://www.inspection.gc.ca">http://www.inspection.gc.ca</a> . [Accessed 21 Feb 2019]	"The mature alfalfa plant is characterized by a strong taproot. This taproot may eventually surpass 6 or more metres in length with several to many lateral roots connected at the crown when alfalfa is grown in deep, well drained, moist soils."
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	"Varieties are available with different root system types: taproot, branching roots, rhizomatous, and creeping (horizontal rootstocks that give rise to independent plants) [94,110]." [Rhizomatous plants able to spread vegetatively]

607	Minimum generative time (years)	1
	Source(s)	Notes
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"An alfalfa plant starts its initial growth from a seed during establishment, but after each harvest or winter it regrows from buds arising from either stubble stems or the crown. The vegetative growth interval (i.e., harvest schedule) during most times of the year is 22 to 40 days. Harvest for forage typically is done two to eight times per year, depending on location and seasonal climate."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	



Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Goat, Horse, Livestock, Sheep, Vehicles, Water, Escapee"
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Natural, nonmechanized seed dispersal is very local, and alfalfa seed is too dense and smooth for effective wind dispersal. In situations where animals feed on alfalfa containing ripe seed pods, seed dispersal by animals also is possible, but seed decay during digestion and/or ensiling may decrease that likelihood (Blackshaw and Rode 1991)."
	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.	[In heavily trafficked areas. Possibly moved accidentally, although seeds lack means of attachment] "in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3-2,075 m,"

702	Propagules dispersed intentionally by people	y
	<b>Source(s)</b>	<b>Notes</b>
	Duke, J. A. (1983). <i>Medicago sativa</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html">https://hort.purdue.edu/newcrop/duke_energy/Medicago_sativa.html</a> . [Accessed 21 Feb 2019]	"Alfalfa or lucerne is a highly valued legume forage, extensively cultivated in warm temperate and cool subtropical regions."
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	"Alfalfa originated in southwestern Asia, was first cultivated in Iran, and now has a worldwide distribution due to its popularity as an agricultural species. It was introduced into the United States in 1736 in Georgia, but it was not until around 1850 that it began to be more widely planted. It is planted in all 50 states and is widely planted in Canada. It is naturalized in many area"
	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 Europe, cultivated as a fodder plant and widely naturalized"

703	Propagules likely to disperse as a produce contaminant	y
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Grapevines, Orchards & Plantations, Pastures, Vegetables"
	Conn, J. S. (2012). Pathways of invasive plant spread to Alaska: III. Contaminants in crop and grass seed. <i>Invasive Plant Science and Management</i> , 5(2): 270-281	[ <i>Medicago sativa</i> seed found as a seed contaminant] "Invasive plants disperse to new areas via numerous pathways. Study of these pathways helps to focus limited budgets toward prevention and early detection. This study examined potentially invasive seed contaminants in imported crops and grass seed as pathways for plant dispersal to Alaska. Crop and grass seed were purchased from 13 Alaska retail outlets representing 14 seed suppliers. Seed bags were sampled using federally mandated protocols and were analyzed for crop seeds that were not supposed to be included and for weed contaminants. Ninety-five weed and 36 contaminant crop taxa were found. Crop seed contained 43 weed taxa and 15 other crop species contaminants, a mean of 6.4 taxa and 3,844 contaminant seed kg <sup>-1</sup> . Grass seed samples contained 73 weed taxa and 21 crop contaminants, a mean of 3.5 contaminant species and 1,250 seeds kg <sup>-1</sup> ."

Qsn #	Question	Answer
	WRA Specialist. (2019). Personal Communication	As a potential weed of crops, and as a commonly cultivated pasture plant, seeds are likely to be dispersed with other crops

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Natural, nonmechanized seed dispersal is very local, and alfalfa seed is too dense and smooth for effective wind dispersal."

705	Propagules water dispersed	
	Source(s)	Notes
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Alfalfa seed is borne in a coiled, leguminous pod and is nonshattering. Natural, nonmechanized seed dispersal is very local, and alfalfa seed is too dense and smooth for effective wind dispersal."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[Possibly secondarily water dispersed if cultivated in proximity to riparian areas] "Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Goat, Horse, Livestock, Sheep, Vehicles, Water, Escapee"

706	Propagules bird dispersed	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Goat, Horse, Livestock, Sheep, Vehicles, Water, Escapee"
	Brochet, A. L., Guillemain, M., Fritz, H., Gauthier-Clerc, M., & Green, A. J. (2009). The role of migratory ducks in the long-distance dispersal of native plants and the spread of exotic plants in Europe. <i>Ecography</i> , 32(6), 919-928	"Table 5. Distribution of seed species found in duck diet which are alien to Europe or which are introduced in at least one European country, according to Flora Europae" [Includes <i>Medicago sativa</i> ]

707	Propagules dispersed by other animals (externally)	n
	Source(s)	Notes
	Van Deynze, A., Fitzpatrick, S., Hammon, B., McCaslin, M., Putnam, D. H., Teuber, L., & Undersander, D. J. (2008). Gene flow in alfalfa: Biology, mitigation, and potential impact on production. Council for Agricultural and Science Technology, Ames, IA	"Natural, nonmechanized seed dispersal is very local, and alfalfa seed is too dense and smooth for effective wind dispersal. In situations where animals feed on alfalfa containing ripe seed pods, seed dispersal by animals also is possible, but seed decay during digestion and/or ensiling may decrease that likelihood (Blackshaw and Rode 1991)."

708	Propagules survive passage through the gut	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Goat, Horse, Livestock, Sheep, Vehicles, Water, Escapee"

Qsn #	Question	Answer
	Cardoso, J. A., Zaitegui, M., & Robles, A. B. (2008). Relationship between seed survival and seed characteristics of nine Mediterranean legumes after ingestion by sheep. <i>Options Méditerranéennes, Series A, No. 79</i> : 285-288	"Table 4. Survival of seeds after 24, 48, 72 and 96h after ingestion by sheep (Segureña race)" [M. sativa Wild survive ingestion. M. sativa Commercial did not survive ingestion]
	Milton, S. J., & Dean, W. R. J. (2001). Seeds dispersed in dung of insectivores and herbivores in semi-arid southern Africa. <i>Journal of Arid Environments, 47(4)</i> , 465-483	"Viable seeds of <i>Medicago sativa</i> L., a native of the Mediterranean basin that is grown as a forage crop in South Africa were found in goat and donkey dung."

801	Prolific seed production (>1000/m2)	
	Source(s)	Notes
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 22 Feb 2019]	"There are approximately 200,000 seeds per pound (441,000 seeds/kg) [50]." [Unknown if seed densities can reach high densities under natural conditions]

802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	"Seeds can be long-lived. Seed stored in unheated sheds attained 81 percent germination after 19 years [54]."
	Wilton, A. C., Townsend, C. E., Lorenz, R. J., & Rogler, G. A. (1978). Longevity of Alfalfa Seed. <i>Crop Science, 18(6)</i> , 1091-1093	"Two hundred twenty-eight lots of alfalfa ( <i>Medicago</i> spp.) seed, ranging in age from 23 to 70 years (stored between 1906 and 1953) were tested for germination. A seed lot represented a plant introduction or open-pollinated seed from a single plant. The seed had been stored in unheated and uninsulated buildings at Belle Fourche, S. D., and Mandan, N. D. One <i>M. falcata</i> L. seed lot germinated 27% after 68 years and a second lot germinated 48% after 66 years of storage. For <i>M. sativa</i> L., one seed lot germinated 7% after 70 years and a second lot germinated 30% after 62 years of storage. <i>Medicago falcata</i> , in most instances, retained seed viability longer than did <i>M. sativa</i> . Significant variation between seed lots of the same species harvested the same year suggests that seed longevity may be genetically controlled. This hypothesis is supported by wide differences in seed longevity of <i>M. sativa</i> and <i>M. falcata</i> . When germination percentage was regressed on years of storage, a correlation coefficient of -0.95 and a linear regression coefficient of -2.23 were found for <i>M. sativa</i> and some of its hybrids. Coefficients were significant at a >0.0001 probability level. Every year of storage between 30 to 70 years presupposed a 2.23% decline in seed germination."

803	Well controlled by herbicides	y

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 21 Feb 2019]	"Application of herbicides to control aspen and prickly rose have a detrimental effect on alfalfa. Alfalfa is sensitive to picloram, 2,4,-D and 2,4,5-T, and is killed at levels applied to control woody species [7]. It may therefore be only beneficial to include alfalfa in such plantings when a mix of 2,4-D and picloram is applied 5 to 10 years after the forage stand is seeded [8]."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	<b>Source(s)</b>	<b>Notes</b>
	Sullivan, J. 1992. <i>Medicago sativa</i> . In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <a href="https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html">https://www.fs.fed.us/database/feis/plants/forb/medsat/all.html</a> . [Accessed 22 Feb 2019]	"As a perennial with a narrow root crown, alfalfa will survive most fires by sprouting after being top-killed. Alfalfa hard seeds may be scarified by moderate-severity fires [126,91]."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	[No evidence. Widely distributed] "in Hawai'i cultivated and naturalized in dry to mesic, disturbed areas such as pastures and roadsides, 3- 2,075 m, on Midway Atoll, Kaua'i, O'ahu, Lana'i, and Hawai'i."
	Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30	[No evidence. Widely distributed] "Known from Midway Atoll, Kaua'i, O'ahu, Lāna'i, East & West Maui, and Hawai'i (Wagner et al., 1990: 686; Wagner & Herbst, 1995: 20; Wagner et al., 1997: 57; Oppenheimer et al., 1999: 8), <i>M. sativa</i> was recently collected on Moloka'i."

**Summary of Risk Traits:**

## High Risk / Undesirable Traits

- Broad climate suitability, and elevation range exceeds 1000 m, demonstrating environmental versatility
- Naturalized in regions with tropical climates
- Naturalized on all main Hawaiian Islands and widely naturalized elsewhere
- Often regarded as an escaped, weedy plant of crops and disturbed natural areas, but generally innocuous or desirable plant
- Other *Medicago* species are invasive
- Allelopathic
- May cause bloat and other diseases of grazing animals, but generally a desired, palatable plant
- Tolerates many soil types (not limited by substrate)
- Reproduces by seeds and vegetatively by rhizomes
- Self-fertile varieties may exist
- Able to reach maturity in one growing season
- Seeds dispersed internally by animals, potentially as a crop contaminant and water and intentionally by people
- Seeds long lived, and may form a persistent seed bank
- Able to resprout after fire

## Low Risk Traits

- Despite reports of weediness, generally regarded as a desirable pasture plant
- Unarmed (no spines, thorns, or burrs)
- Provides fodder for livestock
- Relatively shade intolerant
- Sensitive to herbicides, which may provide effective control if removal is desired