

Family: *Chenopodiaceae*

Taxon: *Chenopodium quinoa*

Synonym: *Common Name:* quinoa
ajara
quinua
arroz del Peru

Questionnaire : current 20090513 **Assessor:** Patti Clifford **Designation:** EVALUATE
Status: Assessor Approved **Data Entry Person:** Patti Clifford **WRA Score** 5

101	Is the species highly domesticated?	y=-3, n=0	y
102	Has the species become naturalized where grown?	y=1, n=-1	
103	Does the species have weedy races?	y=1, n=-1	
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	n
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	y
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic	y=1, n=0	
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens	y=1, n=0	
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	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	y=1, n=-1	y
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	
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	y=1, n=-1	n
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed	y=1, n=-1	n
706	Propagules bird dispersed	y=1, n=-1	
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	
801	Prolific seed production (>1000/m2)	y=1, n=-1	
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	
803	Well controlled by herbicides	y=-1, n=1	
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	

Designation: EVALUATE

WRA Score **5**

Supporting Data:

101	1993. Johnson, D.L./Ward, S.M.. Quinoa In: Janick, J./Simon, J.E. (eds.), New crops. Wiley, New York http://www.hort.purdue.edu/newcrop/proceedings1993/V2-222.html	[Is the species highly domesticated? Yes] "Quinoa has a long and distinguished history in South America. Quinoa has been cultivated in the Andean highlands since 3,000 BC. In the Quechua language of the Incas, quinoa is the chisiya mama or "mother grain;" in Spanish, it is quinoa, trigo inca, or arroz del Peru. Its adaptation to cold, dry climates, seed processing similarity to rice, and excellent nutritional qualities make quinoa a crop of considerable value to highland areas around the world which are currently limited as far as crop diversity and nutritional value."
101	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Is the species highly domesticated? Yes] "The quinoa is a food plant which was extensively cultivated in the Andean region by pre-Columbian cultures some 5000 years ago and was used in the diet of the settlers both of the inter-Andean valleys. which are very cold high areas, and of the high plateaus. After maize. it has occupied the most prominent place among Andean grains." Cultivated quinoas exhibit great genetic diversity, showing variability in the colouring of the plant, inflorescence and seeds, types of inflorescence, protein content, saponin content, beta-cyanine and calcium oxalate crystals in the leaves, so that a wide adaptation to different agro-ecological conditions may be seen (soils, precipitation, temperature, altitude, resistance to frost, drought, salinity or acidity)."
102	2012. WRA Specialist. Personal Communication.	[Has the species become naturalized where grown?] The Global Compendium of Weeds states that <i>Chenopodium quinoa</i> has naturalized in several areas. [information unattainable]
103	1993. Johnson, D.L./Ward, S.M.. Quinoa In: Janick, J./Simon, J.E. (eds.), New crops. Wiley, New York http://www.hort.purdue.edu/newcrop/proceedings1993/V2-222.html	[Does the species have weedy races?] "Quinoa has received a considerable amount of attention in the Andean highlands over the past two decades (Johnson 1990). Quinoa production extends from Columbia to Chile and Argentina and a diversity of landraces have resulted. Within the major quinoa production areas of Columbia, Ecuador, Peru, and Bolivia, Gandarillas (1968) described 17 races based upon morphological characters."
103	1993. Wilson, H./Manhart, J.. Crop/weed gene flow: <i>Chenopodium quinoa</i> Willd. And <i>C. berlandieri</i> Moq.. Theoretical and Applied Genetics. 86: 642-648. http://download.springer.com/static/pdf/829/article%253A10.1007%252FBF00838721.pdf?auth66=1355100797_a775c91d2c	[Does the species have weedy races?] <i>Chenopodium quinoa</i> Willd. Includes both domesticated grain cultivars (subsp. <i>Quinoa</i>) and free-living, weedy types (subsp. <i>milleannum</i> (Aellen) Aellen.
103	2010. Gordon, D.R./Mitterdorfer, B./Pheloung, P.C. et al.. Guidance for addressing the Australian Weed Risk Assessment questions. <i>Plant Protection Quarterly</i> . 25(2): 56-74.	[Does the species have weedy races?] According to Gordon et al. (2010), "only answer this question if the species you are assessing is a sub-species, cultivar or registered variety of a domesticated species. If the taxon is a less weedy subspecies, variety or cultivar, then there must be good evidence that it does not retain the capacity to revert to a weedy form."
103	2012. WRA Specialist. Personal Communication.	[Does the species have weedy races? NA]
201	2012. USDA ARS National Genetic Resources Program. Germplasm Resources Information Network - (GRIN). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl	[Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"? 2 - High] Native range: Bolivia; Colombia; Ecuador; Peru; Chile.
202	2012. USDA ARS National Genetic Resources Program. Germplasm Resources Information Network - (GRIN). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl	[Quality of climate match data? 2 - High] Native range: Bolivia; Colombia; Ecuador; Peru; Chile.
203	1988. Wilson, H.D.. Quinoa biosystematics I: domesticated populations. <i>Economic Botany</i> . 42: 461-477.	[Broad climate suitability (environmental versatility)? Yes] Tapia et al. (1980) described five ecotypic groups of <i>Chenopodium quinoa</i> in Columbia, Ecuador, northern Peru, and at lower elevations (2,400 - 3,600 m) in southern Peru, Bolivia, Argentina; an Altiplano group found at higher elevations in Peru, Bolivia, , Argentina, and northern Chile; a Yungas group adapted to relatively low elevations (1,800 - 2,300 m) of the eastern Andean slopes of Bolivia.

203	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Broad climate suitability (environmental versatility)?] "Chenopodium quinoa's traditional cultivation area extends from lat. 8°N to lat. 30°S, as the plant adapts to different conditions of humidity, altitude and topography. Its requirements are: Precipitation. This depends on the agro-ecological zone and the genotype to which it belongs. It varies from 250 mm (the area of salt deposits in Bolivia) to 1 500 mm in the inter-Andean valleys. Although it shows strong resistance in periods of drought, it requires sufficient humidity at the commencement of cultivation. Temperature. It tolerates down to -5°C in the branching phase, depending on the ecotype and the duration of the minimum temperature. Its ontogenic resistance to cold and drought is very variable. Ecotypes exist which are resistant to temperatures of down to -8°C and survive for 20 days (mean monthly temperature)."
203	2012. Oelke, E.A./Putnam, D.H./Teynor, T.M./Oplinger, E.S.. Quinoa - Alternative field crops manual. University of Wisconsin-Extension, Cooperative Extension, University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extens	[Broad climate suitability (environmental versatility)?] "Quinoa requires short day lengths and cool temperatures for good growth. Areas in South America where it is still produced tend to be marginal agricultural areas that are prone to drought and have soils with low fertility. Cultivated quinoa will flower and produce seed at high elevations between 7,000 and 10,000 ft in Colorado since it requires a cool temperature for good vegetative growth. Research conducted in Colorado reported that temperatures which exceeded 95°F tended to cause plant dormancy or pollen sterility. In several years of trials near the Twin Cities, Minnesota, quinoa plants have failed to set seed; probably due to high temperatures. Quinoa plants are usually tolerant to light frosts (30° to 32°F). Plants should not be exposed to temperatures below 28°F to avoid the 70 to 80% loss that occurred in Colorado during 1985 when plants were in mid-bloom (Johnson and Croissant, 1990). However, plants are not affected by temperatures down to 20°F after the grain has reached the soft-dough stage. Quinoa will flower earlier when grown in areas with shorter day lengths. Quinoa is generally not a widely adapted crop due to temperature sensitivity. Farmers should experiment first before planting large acreages."
204	2012. USDA ARS National Genetic Resources Program. Germplasm Resources Information Network - (GRIN). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl	[Native or naturalized in regions with tropical or subtropical climates? Yes] Native range: Bolivia; Colombia; Ecuador; Peru; Chile.
205	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Does the species have a history of repeated introductions outside its natural range? No] "At present. it continues to be grown in Colombia. Ecuador. Peru, Bolivia. Chile and Argentina. Its marginalization began with the introduction of cereals such as barley and wheat, which eventually replaced it. The reduction in its cultivated area in the Andean countries is also due to technical. economic and social reasons. Harvesting and threshing, which in the majority of cases are done by hand, take a great many days and the grain requires a process to remove its bitter ingredients before consumption. The prices received by farmers often do not justify their labour."
205	2009. European Food Safety Authority. Scientific opinion - Saponins in <i>Madhuca longifolia</i> L. as undesirable substance in animal feed. The EFSA Journal. 979: 1-36. http://www.efsa.europa.eu/de/scdocs/doc/979.pdf	[Does the species have a history of repeated introductions outside its natural range? No] <i>Chenopodium quinoa</i> is not grown widely in the European Union (EU), and there are no reports of the use of quinoa as a feed for livestock. Most quinoa is sold commercially as health food in North America, after removal of the seed coat.
301	2012. WRA Specialist. Personal Communication.	[Naturalized beyond native range?] The Global Compendium of Weeds states that <i>Chenopodium quinoa</i> has naturalized in several areas. [information unattainable]
302	2012. viarural. Malezas en cultivos - Clasificadas por nombres comunes [Accessed 29 November 2012]. http://www.viarural.com.ar/	[Garden/amenity/disturbance weed? Yes] <i>Chenopodium quinoa</i> is documented as an agricultural weed in Argentina. However, since there is no information on its productivity losses or costs due to control, it is scored under question 3.02 (garden/amenity disturbance weed), according to protocol.
303	2012. viarural. Malezas en cultivos - Clasificadas por nombres comunes [Accessed 29 November 2012]. http://www.viarural.com.ar/	[Agricultural/forestry/horticultural weed? No] <i>Chenopodium quinoa</i> is documented as an agricultural weed in Argentina. However, since there is no information on its productivity losses or costs due to control, it is scored under question 3.02 (garden/amenity disturbance weed), according to protocol.
304	2012. Randall, R.P.. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	[Environmental weed? No] No evidence.

305	1997. Holm, L.G./Doll, J./Holm, E./Pancho, J.V./Herberger, J.P.. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	[Congeneric weed? Yes] <i>Chenopodium murale</i> is a widespread noxious weed infesting more than 25 crop species (mainly field crops) and tree orchards in at least 57 countries around the world.
305	2012. National Institute for Environmental Studies. Invasive species of Japan - <i>Chenopodium pumilio</i> . http://www.nies.go.jp/biodiversity/invasive/DB/detail/80050e.html	[Congeneric weed? Yes] <i>Chenopodium pumilio</i> is an invasive species in Japan where it competes with native plants and crops.
401	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Produces spines, thorns or burrs? No] " <i>C. quinoa</i> is an annual herbaceous plant, measuring 0.20 to 3 m in height, depending on environmental conditions and genotype. It has a racemose inflorescence (a panicle with groups of flowers in glomerules); small, incomplete, sessile flowers of the same colour as the sepals and they may be hermaphrodite, pistillate or male sterile. The stamens have short filaments bearing basifixed anthers; the style has two or three feathery stigmas. The fruit occurs in an indehiscent achene, protected by the perigonium. The seeds are 1 to 2.6 mm and are white, yellow, red, purple, brown or black. The leaves show pronounced polymorphism: rhomboid, deltoid or triangular. The taproot is densely branched."
402	2012. WRA Specialist. Personal Communication.	[Allelopathic? Unknown]
403	2010. Nickrent, D.. The parasitic plant connection. Department of Plant Biology, Southern Illinois University, Carbondale http://www.parasiticplants.siu.edu/index.html	[Parasitic? No] Chenopodiaceae.
404	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Unpalatable to grazing animals? No] The whole plant is used as green fodder. Harvest residues are also used to feed cattle, sheep, pigs, horses and poultry.
404	2007. Franco, J./Main, G.. Management of nematodes of Andean tuber and grain crops In: Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes. Springer, http://books.google.com/books?id=fa7cXAE80zsC&pg=PA102&lpg=PA102&dq=chenopodium+q	[Unpalatable to grazing animals? No] The whole plant is used as fodder. Harvest residues are fed to cattle, sheep, pigs, horses and poultry.
405	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Toxic to animals? No] The whole plant is used as green fodder. Harvest residues are also used to feed cattle, sheep, pigs, horses and poultry.
405	2007. Franco, J./Main, G.. Management of nematodes of Andean tuber and grain crops In: Integrated Management and Biocontrol of Vegetable and Grain Crops Nematodes. Springer, http://books.google.com/books?id=fa7cXAE80zsC&pg=PA102&lpg=PA102&dq=chenopodium+q	[Toxic to animals? No] The whole plant is used as fodder. Harvest residues are fed to cattle, sheep, pigs, horses and poultry.
406	2012. Oelke, E.A./Putnam, D.H./Teynor, T.M./Oplinger, E.S.. Quinoa - Alternative field crops manual. University of Wisconsin-Extension, Cooperative Extension, University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extens	[Host for recognized pests and pathogens] "Disease and pest problems may arise after a crop like quinoa is introduced to a new production area. Viruses found on spinach or beets have been observed in quinoa fields. Many of these viruses are transmitted by aphids or leafhoppers. Several of the viruses tested produce symptoms, yet research needs to be conducted to determine if any cause significant damage. Diseases such as damping off (<i>Sclerotium rolfsii</i>), downy mildew (<i>Peronospora farinosa</i>), stalk rot (<i>Phoma exigua</i> var. <i>foveata</i>), leaf spot (<i>Ascochyta hyalospora</i>), grey mold (<i>Botrytis cinerea</i>), and bacterial blight (<i>Pseudomonas</i> sp.) have also caused significant losses in South America, North America, and Great Britain."

407	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Causes allergies or is otherwise toxic to humans? No] Grains and leaves are used for food, and the grains, stems and leaves are used medicinally.
407	2011. Diaz, G.J.. Toxic plants of veterinary and agricultural interest in Columbia. International Journal of Poisonous Plant Research. 1: 7-19. http://www.ars.usda.gov/is/np/PoisonousPlants/PoisonousPlantResearch.pdf	[Causes allergies or is otherwise toxic to humans? No] Chenopodium quinoa is considered native to Columbia, but has not been reported as toxic.
408	2012. WRA Specialist. Personal Communication.	[Creates a fire hazard in natural ecosystems? No] No evidence of biomass accumulation.
409	2012. Dave's Garden. PlantFiles: Chenopodium quinoa. http://davesgarden.com/guides/pf/go/183413/	[Is a shade tolerant plant at some stage of its life cycle? No] Full sun.
409	2012. Missouri Botanical Garden. Chenopodium quinoa. http://www.missouribotanicalgarden.org/gardens-gardening/your-garden/plant-finder/plant-details/kc/a676/chenopodium-quinoa.aspx	[Is a shade tolerant plant at some stage of its life cycle? No] Full sun.
410	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)? Yes.] "Soil. It prefers easily worked, semi-deep soils, with good drainage and a supply of nutrients. It is suited to acid soils with a pH of 4.5 (in Cajamarca, Peru) and alkaline soils with a pH of up to 9.5 (in Uyuni, Bolivia), depending on the ecotype. Acceptable production is also obtained both on sandy and clayey soils."
410	2012. Dave's Garden. PlantFiles: Chenopodium quinoa. http://davesgarden.com/guides/pf/go/183413/	[Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)? Yes.] Soil pH requirements: 5.1 to 5.5 (strongly acidic) 5.6 to 6.0 (acidic) 6.1 to 6.5 (mildly acidic) 6.6 to 7.5 (neutral) 7.6 to 7.8 (mildly alkaline) 7.9 to 8.5 (alkaline) 8.6 to 9.0 (strongly alkaline)
410	2012. Oelke, E.A./Putnam, D.H./Teynor, T.M./Oplinger, E.S.. Quinoa - Alternative field crops manual. University of Wisconsin-Extension, Cooperative Extension, University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extens	[Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)? Yes.] "This crop grows well on sandy-loam to loamy-sand soils. Marginal agricultural soils are frequently used in South America to grow quinoa. These soils have poor or excessive drainage, low natural fertility, or very acidic (pH of 4.8) to alkaline (8.5) conditions."
411	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Climbing or smothering growth habit? No] Herbs, annual or perennial [rarely suffruticose, or small trees]. [Genus-level description]
412	2012. WRA Specialist. Personal Communication.	[Forms dense thickets? No] No evidence.
501	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Aquatic? No] " Chenopodium quinoa is an annual herbaceous plant, measuring 0.20 to 3 m in height, depending on environmental conditions and genotype."
502	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Grass? No] Chenopodiaceae.
503	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Nitrogen fixing woody plant? No] " Chenopodium quinoa is an annual herbaceous plant, measuring 0.20 to 3 m in height, depending on environmental conditions and genotype."

504	1997. Smith, N.O./Maclean, I./Miller, F.A./Carruthers, S.P.. Crops for Industry and Energy in Europe. European Commission Directorate General XII E-2 Agro-industrial Research Unit, http://ec.europa.eu/research/agriculture/pdf/crops_for_industry_and_energ	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] The root system is deeply-penetrating, with many laterals.
601	1988. Wilson, H.D.. Quinoa biosystematics I: domesticated populations. <i>Economic Botany</i> . 42: 461-477.	[Evidence of substantial reproductive failure in native habitat? No] "Tapia et al. (1980), using distributional, ecological, agronomic, and morphological criteria, described five ecotypic "groups" of quinoa. These include a Valle group occurring in Colombia, Ecuador, northern Peru, and at lower elevations (2,400-3,600 m) in southern Peru, Bolivia, and Argentina; an Altiplano group found at higher elevations in Peru, Bolivia, Argentina, and northern Chile; a Yungas group adapted to relatively low elevations (1,800-2,300 m) of the eastern Andean slopes of Bolivia; a Salares group cultivated in salt flats of southwestern Bolivia; and a Nivel del Mar group adapted for cultivation near sea level along the south-central coast of Chile. This alignment, based on a diverse array of characters, appears to include the full range of variation among domesticated forms of the species."
602	2012. Dave's Garden. PlantFiles: <i>Chenopodium quinoa</i> . http://davesgarden.com/guides/pf/go/183413/	[Produces viable seed? Yes] Propagation Methods: From seed; direct sow outdoors in fall From seed; direct sow after last frost
602	2012. Oelke, E.A./Putnam, D.H./Teynor, T.M./Oplinger, E.S.. Quinoa - Alternative field crops manual. University of Wisconsin-Extension, Cooperative Extension, University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extens	[Produces viable seed? Yes] "Quinoa prefers cool soil conditions (45° to 50°F). Germination occurs within 24 hours after planting when adequate moisture is present, and seedlings emerge in three to five days. Quinoa seeds, like those of spinach, may not germinate if conditions are warm and may need to be refrigerated for a week (vernalized) to obtain adequate germination."
603	1993. Wilson, H./Manhart, J.. Crop/weed gene flow: <i>Chenopodium quinoa</i> Willd. And <i>C. berlandieri</i> Moq.. <i>Theoretical and Applied Genetics</i> . 86: 642-648. http://download.springer.com/static/pdf/829/art%253A10.1007%252FBF00838721.pdf?auth66=1355100797_a775c91d2c	[Hybridizes naturally? Yes] "Introduction of the Andean grain chenopod (<i>Chenopodium quinoa</i>) into North America placed this crop within the distributional range of a related wild species, <i>C. berlandieri</i> . This wild species, native to the North American flora, is cross-compatible with <i>C. quinoa</i> . Isozyme analysis of progeny from <i>C. berlandieri</i> plants growing within and at the periphery of the <i>C. quinoa</i> fields, combined with fertility assessment and phenetic comparison among putative hybrids and parental types, indicates that over 30% of progeny from wild plants growing as weeds with <i>C. quinoa</i> in 1987 were crop/weed hybrids."
604	1993. Johnson, D.L./Ward, S.M.. Quinoa In: Janick, J./Simon, J.E. (eds.), <i>New crops</i> . Wiley, New York http://www.hort.purdue.edu/newcrop/proceedings1993/V2-222.html	[Self-compatible or apomictic? Yes] "Quinoa is primarily an inbreeding species with plants bearing hermaphroditic flowers. Ward (1991) has found the hermaphroditic nature of quinoa to be variable. In a study of male sterility, male fertile plants were found to possess anthers in only 10 to 90% of the inflorescences, with fertile flowers concentrated at the distal ends of the flower cluster. Outcrossing exceeds 10% (D.L. Johnson unpublished). These outcrossing estimates are similar to those reported in South America."
604	2012. George, R.A.T.. <i>Agricultural seed production</i> . CABI, http://books.google.com/books?id=b6jaoYMZPZYC&pg=PA172&lpg=PA172&dq=chenopodium+quinoa+%2B+%22seed++production%22&source=bl&ots=Eqw1i565L9&sig=4ugDRWcjzv76M0vyp6X4Z6GP9NA&hl=en&sa=X&ei=RrnCUI3IC4S	[Self-compatible or apomictic? Yes] Self-fertilizing.
605	1993. Johnson, D.L./Ward, S.M.. Quinoa In: Janick, J./Simon, J.E. (eds.), <i>New crops</i> . Wiley, New York http://www.hort.purdue.edu/newcrop/proceedings1993/V2-222.html	[Requires specialist pollinators? No] "Wind pollination studies of fertile quinoa (CO 407) with an orange panicle by a red-panicled near-isoline (CO 407R) indicate pollen to move 36 cm. Plants samples beyond that distance show no cross pollination to the CO 407R source in any direction. No insect activity in flowers was observed, although various Diptera spp. have been observed to visit quinoa flowers in Colorado's San Luis Valley and may add to wind distribution of pollen."
605	2012. George, R.A.T.. <i>Agricultural seed production</i> . CABI, http://books.google.com/books?id=b6jaoYMZPZYC&pg=PA172&lpg=PA172&dq=chenopodium+quinoa+%2B+%22seed++production%22&source=bl&ots=Eqw1i565L9&sig=4ugDRWcjzv76M0vyp6X4Z6GP9NA&hl=en&sa=X&ei=RrnCUI3IC4S	[Requires specialist pollinators? No] Self-fertilizing.

606	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Reproduction by vegetative fragmentation?] "The taproot is densely branched."
606	2012. WRA Specialist. Personal Communication.	[Reproduction by vegetative fragmentation? Unknown] [there is a well-developed root system]
607	2003. Prim, L.. Growing and harvesting quinoa & amaranth. The Cutting Edge. 38: .http://www.seedsofchange.com/enewsletter/issue_38/quinoa.aspx	[Minimum generative time (years)? 1] Most quinoa varieties mature in 3 to 6 months and in some varieties, the plants mature at varying rates.
607	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Minimum generative time (years)? 1] Annual.
701	1997. Smith, N.O./Maclean, I./Miller, F.A./Carruthers, S.P.. Crops for Industry and Energy in Europe. European Commission Directorate General XII E-2 Agro-industrial Research Unit, http://ec.europa.eu/research/agriculture/pdf/crops_for_industry_and_energ	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] Domesticated agricultural crop. Some agronomic and breeding work has been undertaken in several European countries, particularly Denmark, the Netherlands and the United Kingdom, where small commercial areas have been grown for several years.
701	2009. European Food Safety Authority. Scientific opinion - Saponins in <i>Madhuca longifolia</i> L. as undesirable substance in animal feed. The EFSA Journal. 979: 1-36. http://www.efsa.europa.eu/de/scdocs/doc/979.pdf	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] <i>Chenopodium quinoa</i> is not grown widely in the European Union (EU), and there are no reports of the use of quinoa as a feed for livestock. Most quinoa is sold commercially as health food in North America, after removal of the seed coat.
702	1997. Smith, N.O./Maclean, I./Miller, F.A./Carruthers, S.P.. Crops for Industry and Energy in Europe. European Commission Directorate General XII E-2 Agro-industrial Research Unit, http://ec.europa.eu/research/agriculture/pdf/crops_for_industry_and_energ	[Propagules dispersed intentionally by people? Yes] Some agronomic and breeding work has been undertaken in several European countries, particularly Denmark, the Netherlands and the United Kingdom, where small commercial areas have been grown for several years.
702	2009. European Food Safety Authority. Scientific opinion - Saponins in <i>Madhuca longifolia</i> L. as undesirable substance in animal feed. The EFSA Journal. 979: 1-36. http://www.efsa.europa.eu/de/scdocs/doc/979.pdf	[Propagules dispersed intentionally by people? Yes] <i>Chenopodium quinoa</i> is not grown widely in the European Union (EU), and there are no reports of the use of quinoa as a feed for livestock. Most quinoa is sold commercially as health food in North America, after removal of the seed coat.
703	2012. WRA Specialist. Personal Communication.	[Propagules likely to disperse as a produce contaminant? No] Grown as a crop.
704	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Propagules adapted to wind dispersal? No] Seeds are generally flattened and lentil-like. The equatorial edge (here called margin) may be rounded, flattened, or grooved. The surface is usually honey combed or smooth. All leaf characteristics refer to primary, well-developed leaves; those often fall early, however, so smaller, upper leaves often are shorter, narrower, and less lobed. [genus-level description]
705	2003. Prim, L.. Growing and harvesting quinoa & amaranth. The Cutting Edge. 38: .http://www.seedsofchange.com/enewsletter/issue_38/quinoa.aspx	[Propagules water dispersed? No] Once the dry seeds are removed they can be placed into a shallow bowl and swirled around until the large pieces of flowers rise to the top where they are easy to remove. By tipping the bowl you can rake out much of the chaff that is left.
705	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Propagules water dispersed?] Seeds are generally flattened and lentil-like. The equatorial edge (here called margin) may be rounded, flattened, or grooved. The surface is usually honey combed or smooth. All leaf characteristics refer to primary, well-developed leaves; those often fall early, however, so smaller, upper leaves often are shorter, narrower, and less lobed. [genus-level description]
706	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Propagules bird dispersed?] Seeds are generally flattened and lentil-like. The equatorial edge (here called margin) may be rounded, flattened, or grooved. The surface is usually honey combed or smooth. All leaf characteristics refer to primary, well-developed leaves; those often fall early, however, so smaller, upper leaves often are shorter, narrower, and less lobed. [genus-level description]

707	2012. eFloras.org. Flora of North America Vol. 4 - Chenopodiaceae. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=106630	[Propagules dispersed by other animals (externally)? No] Seeds are generally flattened and lentil-like. The equatorial edge (here called margin) may be rounded, flattened, or grooved. The surface is usually honey combed or smooth. All leaf characteristics refer to primary, well-developed leaves; those often fall early, however, so smaller, upper leaves often are shorter, narrower, and less lobed. [genus-level description]
708	1979. Wilson, H.D./Heiser, C.B.. The origin and evolutionary relationships of 'Huauzontle' (<i>Chenopodium nuttalliae</i> Safford) domesticated chenopod of Mexico. American Journal of Botany. 66: 198-206.	[Propagules survive passage through the gut?] "Wild type mechanisms for fruit dispersal and germination dormancy have been lost, fruit size has increased dramatically in grain cultivars and fruit of most cultivars is light colored because of an extreme reduction of the testa."
708	2012. WRA Specialist. Personal Communication.	[Propagules survive passage through the gut? Unknown]
801	1993. Schlick, G./Bubenheim, D.L.. Quinoa: An emerging "new" crop with potential for CELSS. NASA, http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19940015664_1994015664.pdf	[Prolific seed production (>1000/m ²)] Today with improved commercial and experimental farming harvesting techniques, yields greater than 2,200-3,300 kg ha ⁻¹ are becoming common.
802	1994. Hernando Bermejo, J.E./Leon, J. (eds.). Neglected crops: 1492 from a different perspective. Plant Production and Protection Series No. 26. FAO, Rome http://www.hort.purdue.edu/newcrop/1492/grains.html#Quinoa	[Evidence that a persistent propagule bank is formed (>1 yr)? No] "The quinoa has the ability to adapt to adverse environmental conditions such as cold and drought. Its seeds do not exhibit dormancy and they germinate when conditions are suitable, even on the plant itself although, in the wild forms, they may remain in the soil for two to three years without germinating."
802	2012. George, R.A.T.. Agricultural seed production. CABI, http://books.google.com/books?id=b6jaoYMZPZYC&pg=PA172&lpg=PA172&dq=chenopodium+quinoa+%2B+%22seed++production%22&source=bl&ots=Eqw1i565L9&sig=4ugDRWcjzv76M0vyp6X4Z6GP9NA&hl=en&sa=X&ei=RrnCUI3IC4S	[Evidence that a persistent propagule bank is formed (>1 yr)?] <i>Chenopodium quinoa</i> seeds can survive in the soil for several years.
802	2012. Kew Royal Botanic Gardens. Difficult seeds project - <i>Chenopodium quinoa</i> . http://www.kew.org/science-research-data/kew-in-depth/difficult-seeds/species-profiles/chenopodium-quinoa/index.htm	[Evidence that a persistent propagule bank is formed (>1 yr)?] This species has Orthodox seeds - dry to 15-20% eRH and store at -20°C, or as cool as possible.
803	1993. Johnson, D.L./Ward, S.M.. Quinoa In: Janick, J./Simon, J.E. (eds.), New crops. Wiley, New York http://www.hort.purdue.edu/newcrop/proceedings1993/V2-222.html	[Well controlled by herbicides?] "Weed control via herbicides have been effective and several show promise. In England, Metamazide, Propachlor, Linuron, Propyzamide, and aloxium sodium did not significantly reduce plant stands of two quinoa cultivars (Galwey and Risi 1984). In Colorado, preliminary herbicide studies of pre-emerge herbicides with Dual, Furloe, Sutan, and Antor showed good crop safety and control of grasses and many broadleaf weeds (Westra 1988). Post-emergent control was best for Poast, Tough, and Probe, with Tough and Probe at lower rates (Westra 1988)."
803	2012. WRA Specialist. Personal Communication.	[Well controlled by herbicides? Unknown]
804	2012. WRA Specialist. Personal Communication.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Unknown]
805	2012. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]

Summary of Risk Traits

High Risk / Undesirable Traits

- Chenopodium quinoa is native to tropical/sub-tropical regions and at higher elevations
- Hybridization ability within the species and genus
- Self-compatible (doesn't require pollinators)
- Congeneric invasive species (several species in this genus are highly invasive)
- Possible herbicide tolerance
- Seed bank longevity is not well-understood at this time
- Partially bred for prolific seed production
- Short life-cycle
- Unclear in the literature if seeds are bird-dispersed
- Probable accidental dispersal from agricultural fields

Low Risk / Desirable Traits

- Limited dispersal ability, perhaps by humans purposefully and accidentally
- Palatable to animals
- Non-toxic to humans and animals
- Requires full sun to thrive