NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SALINITY AND SODIC SOIL MANAGEMENT
(Ac)
Code 610

DEFINITION

Management of land, water and plants to control and minimize accumulations of salts and/or sodium on the soil surface and in the crop rooting zone.

PURPOSE

To reduce and control harmful salt concentrations in the root zone

To reduce problems of crusting, permeability, or soil structure on sodium affected soils

To promote desired plant growth and to utilize excess water in the root zone in non-irrigated saline seep areas and their recharge areas.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where the concentration or toxicity of salt limits the growth of desirable plants or where excess sodium causes crusting and permeability problems. This practice also applies to non-irrigated land where a combination of factors such as topography, soils, geology, precipitation, vegetation, land use and cultural/structural practices can increase the extent and concentration of salts in saline seep areas.

CRITERIA

General Criteria Applicable to All Purposes

All work, including associated practices for management of drainage and runoff, shall comply with Federal, State, and local laws and regulations.

Type and rate of application of soil amendments shall be based on the chemistry of both the soil water and irrigation water (where applicable) regarding concentrations and types of salts and/or sodium, sodium adsorption ratio (SAR or RNa), exchangeable sodium percentage (ESP), concentration and types of salts, and pH.

Improve surface and subsurface drainage as needed to reduce localized ponding and or high water tables.

Additional Criteria to Reduce Salt Concentrations in the Root Zone on Saline Soils

On irrigated lands, leaching requirements shall be determined as presented in National Engineering Handbook Part 623, Chapter 2.

On non-irrigated land or where shallow water tables limit the use of leaching, reclamation shall utilize vegetative methods, soil amendments, and/or enhanced drainage to effect a reduction in soil salinity.

Additional Criteria to Reduce Problems of Crusting, Permeability or Soil Structure on Sodium-affected (Sodic) Soils.

Change the plant species or variety to a more tolerant species or variety.

Change the soil by applying soil amendments containing soluble calcium, or that cause calcium in the soil to become available.

Dissolve the limestone or gypsum already present in the soil.

On non-irrigated land, reclamation shall utilize vegetative methods and/or soil amendments to reduce problems of crusting, permeability or soil structure on sodium-affected soils.

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Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact the MN Natural Resources Conservation Service in your area, or download it from the electronic Field Office Technical Guide for Minnesota

Additional Criteria Specific to Saline Seeps and Their Recharge Areas

Plant and/or maintain adapted high water use vegetation in recharge and seep areas to utilize soil water.

CONSIDERATIONS

Soil salinity levels can be monitored to minimize the effects of salinity on crops and to evaluate management practices.

Tools such as electromagnetic induction (EMI) and salinity probes are appropriate for evaluating and for monitoring soil salinity levels. On-site transects and visual observations of crop response can be used to arrive at preponderance of salinity.

The drainage water from this practice may have high levels of salts. Select an outlet or disposal area that will minimize the effects of this saline water.

Planned actions should give first consideration to prevention rather than correction.

Saline soils cannot be reclaimed by chemical amendments, conditioners or fertilizer. Leaching salts from the plant root zone or planting salt-tolerant crops may be needed.

Removal of salts from the root zone by leaching operations may increase contamination of water tables. Avoid excessive leaching and schedule leaching operations during seasons when potential contaminants in the soil profile, such as nitrogen, are low.

For irrigated conditions, an irrigation water management plan should minimize non-point pollution of surface and groundwater resources.

Chiseling and subsoiling can improve permeability, root penetration and aeration where water movement is restricted by layered soils. Avoid inversion tillage that can bring salinity to the surface and interrupt the leaching process.

Green manure crops or applications of organic matter can improve soil structure and permeability.

Polyacrylamides may improve effectiveness of leaching and reclamation of some soils.

Applications of gypsum, sulfur or calcium will help in displacing sodium from the root zone for sodic soils.

Water of slight to moderate salinity not dominated by sodium can enhance leaching of salts.

Residue management can improve the organic matter content of the soil, improve infiltration and minimize surface evaporation and capillary rise of salts to the soil surface.

Consider selecting crops with tolerance to salinity/ sodium levels in the soil.

Consider using bedding and planting methods designed to reduce salinity near plant root zone, especially for germinating seeds.

Consider restoring wetlands that are drained but unproductive due to natural or human-induced salinity.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

No operation and maintenance requirements, national in scope, have been identified for this practice.

REFERENCES

Ayers, R.S., and D.W. Westcot, 1994. FAO Irrigation and Drainage Paper 29 Rev. 1, Water Quality For Agriculture.

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California Fertilizer Association. 1998. Water and plant growth. p. 21-66. *In* Western Fertilizer Handbook. Interstate Publishers, Inc., Danville, Illinois.

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USDA. 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60. Washington, DC.

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Specifications

Excessive soil salinity reduces the yield of many crops. This ranges from a slight crop loss to complete crop failure, depending on the type of crop and the severity of the salinity problem.

Although several treatments and management practices can reduce salt levels in the soil, there are some situations where it is either impossible or too costly to attain desirably low soil salinity levels. In some cases, the only viable management option is to plant salt-tolerant crops. See the following table for the relative salt tolerance of field, forage and vegetable crops. Crops in each category are generally listed in order of decreasing salt tolerance.

Potential yield reduction from saline soils for selected crops

	Relative yield decrease (%)			
	0	**10**	**25**	**50**
		ECe (electrical conductivity in dS/m)		
Field Crops				
Barley	8.0	10.0	13.0	18.0
Sugarbeets*	7.0	8.7	11.0	15.0
Wheat	6.0	7.4	9.5	13.0
Sorghum	4.0	5.1	7.2	11.0
Soybean	5.0	5.5	6.2	7.5
Corn	1.7	2.5	3.8	5.9
Bean	1.0	1.5	2.3	3.6
Forages				
Tall wheatgrass	7.5	9.9	13.3	19.4
Crested wheatgrass	3.5	6.0	9.8	16.0
Tall fescue	3.9	5.8	8.6	13.3
Orchardgrass	1.5	3.1	5.5	9.6
Alfalfa	2.0	3.4	5.4	8.8
Meadow foxtail	1.5	2.5	4.1	6.7
Clover: alsike, Red, ladino	1.5	2.3	3.6	5.7
Vegetables				
Broccoli	2.8	2.9	5.5	8.2
Cucumber	2.5	3.3	4.4	6.3
Cantaloupe	2.2	3.6	5.7	9.1
Spinach	2.0	3.3	5.3	8.6
Cabbage	1.8	2.8	4.4	7.0
Potato	1.7	2.5	3.8	5.9
Sweet corn	1.7	2.5	3.8	5.9
Lettuce	1.3	2.1	3.2	5.2
Onion	1.2	1.8	2.8	4.3
Carrot	1.0	1.7	2.8	4.6

CROP	**SALT TOLERANCE OF GERMINATING PLANTS**	**SALT TOLERANCE OF ESTABLISHED PLANTS**
Dry Bean	Very low	Very low
Sugarbeet	Low	High
Alfalfa	Low	Low-medium
Corn	Medium	Low-medium
Wheat	Medium	Low-medium
Barley	High	High

Table 2. Crop salt tolerance ratings, row crops and grains, annual forages.

Crop	Relative tolerance* S	MS	MT	T	Source
Alfalfa		X			Bernstein & Francois, 1973
Barley				X	Hassan et al., 1970a
Beans, dry	X				Osawa, 1965
Canola (rapa)				X	Francois, 1994
Canola (napus)				X	Francois, 1994
Chickpea		X			Manchanda & Sharma, 1989
Corn		X			Hassan et al., 1970b
Crambe		X			Francois & Kleiman, 1990
Flax		X			Hayward & Spurr, 1944
Millet		X			Maas & Grattan, 1999

Crop	S	MS	MT	T	Source
Corn	X				USDA, NRCS, Bridger PMC Montana, Tech Note 26
Oat		-	X		US Salinity Lab, 1954
Potato		X			Bernstein et al., 1951
Rye				X	Francois, 1989
Safflower			X		Francois & Bernstein, 1964
Sorghum			X		Francois et al., 1984
Soybean			X		Bernstein & Ogata, 1966
Sudangrass			X		Bower et al., 1970
Sugarbeet				X	Bower et al., 1954
Sunflower			X		Francois, 1996
Wheat			X		Asana & Kal, 1965
Wheat, semidwarf				X	Francois et al., 1986
Wheat, durum				X	Francois et al., 1986

* S = sensitive, MS = moderately sensitive, MT = moderately tolerant, T = tolerant
**estimated value based on a medium soil

Table 3. Crop salt tolerance ratings, pasture and hay grasses.

Crop	Relative tolerance* S	MS	MT	T	Source
Alkaligrass Nuttall	-		-	X	US Salinity Lab, 1954
Alkali sacaton	-		-	X	US Salinity Lab, 1954
Brome, smooth	-		X		McElgunn & Lawrence, 1973
Fescue, tall	-		X		Bower et al., 1970
Grama, blue	-	X			US Salinity Lab, 1954
Ryegrass, perennial			X		Brown & Bernstein, 1953
Timothy	-	X			Saini, 1972
Wheatgrass, fairway crested				X	McElgunn & Lawrence, 1973
Wheatgrass, slender			X		McElgunn & Lawrence, 1973
Wheatgrass, tall				X	Bernstein & Ford, 1958
Wheatgrass, western			X		US Salinity Lab, 1954
Wheatgrass, intermediate			X		Dewey, 1960
Wildrye, beardless			X		Brown & Bernstein, 1953
Wildrye, Canada			X		US Salinity Lab, 1954
Wildrye, Russian	-			X	McElgunn & Lawrence, 1973
Smooth brome			x		USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Birdsfoot trefoil	X				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Orchardgrass	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Reed Canarygrass	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
White Clover	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Alsike clover	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Red Clover	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26
Ladino clover	x				USDA, NRCS, Bridger PMC, Montana, Tech Note 26

* S = Sensitive, MS = Moderately sensitive, MT = Moderately tolerant, T = tolerant
**estimated value based on a medium soil

Table 4. Crop salt tolerance ratings, vegetables.

Crop	Relative tolerance* S	MS	MT	T	Source
Bean	X				Osawa, 1965
Cabbage		X			Bernstein & Ayers, 1949
Carrot	X				Bernstein et al., 1964
Corn, sweet		X			Bernstein & Ayers, 1949
Cucumber		X			Ploagman & Biehuizen, 1970
Lettuce		X			Bernstein et al., 1974
Muskmelon		X			Shannon & Francois, 1978
Onion	X				Hoffman & Rawlins, 1971
Pea		X			Cerdá et al., 1982
Pepper		X			Osawa, 1965
Pumpkin	-	X			Maas & Grattan, 1999
Radish		X			Hoffman & Rawlins, 1971
Crop	**Relative tolerance* S**	**MS**	**MT**	**T**	**Source**
Squash, zucchini			X		Graifenberg et al., 1996
Strawberry	X				Osawa, 1965
Sweet potato		X			Greig & Smith, 1962
Tomato		X			Bierhuizen & Ploagman, 1967
Turnip		X			Francois, 1984
Watermelon	-	X			deForges, 1970

* S = sensitive, MS = moderately sensitive, MT = moderately tolerant, T = tolerant
**estimated value based on a medium soil

Table 5. Relative crop yields at increasing levels of soil EC.

	Electrical conductivity, Ece dS/m, saturated paste method											
	2	4	6	8	10	12	14	16	18	20	22	24
Crop	Percent (%) of maximum yield potential											
Alfalfa	100	85	71	56	42	27	12	0	0	0	0	0
Barley	100	100	100	100	90	80	70	60	50	40	30	20
Canola (napus)	100	100	100	100	100	87	61	35	9	0	0	0
Corn	96	72	48	24	0	0	0	0	0	0	0	0
Dry bean	81	43	5	0	0	0	0	0	0	0	0	0
Flax	96	72	48	24	0	0	0	0	0	0	0	0
Soybean	100	100	90	50	10	0	0	0	0	0	0	0
Sugarbeet	100	100	100	97	85	73	61	49	37	25	13	0
Sunflower	100	100	97	87	77	67	57	47	37	27	17	7
Wheat, durum	100	100	100	96	88	80	72	64	56	48	40	32
Wheat, semidwarf	100	100	100	92	84	76	68	60	52	44	36	28