NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
SALINITY AND SODIC SOIL MANAGEMENT

(Acre)

CODE 610

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

PURPOSES
Improve soil health by reducing:
- salt concentrations in the root zone
- problems of crusting, permeability, or soil structure on sodium affected soils
- soil salinization and/or discharge of saline water tables at or near the soil surface downslope from saline seep recharge areas

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to all land uses where one or more of the following conditions exist:
- The concentration or toxicity of salt limits the growth of desirable plants
- Excess sodium causes crusting and permeability problems
- Saline seep recharge and discharge areas

CRITERIA

General Criteria Applicable to All Purposes
Use of this standard requires compliance with all applicable federal, state, and local laws and regulations.
Localized ponding that persists for more than 24 hours after irrigation or precipitation events will be alleviated by improvements to surface drainage.

In crop areas, shallow water tables will be maintained below depths that cause salt accumulation in the root zone. Where depth to shallow water cannot be maintained by proper irrigation water management or by cropping practices, drainage will be improved by one or more of the following:
- Interception and diversion of the subsurface inflows.
- Subsoiling where internal soil drainage is restricted by layers of contrasting permeability and soil moisture levels are low enough to allow shattering and mixing of soil layers.
- Installation of surface and/or subsurface drainage systems.
- Grading and shaping operations will be planned to permit the use of conventional tillage equipment and to provide positive drainage where needed.
- Other Field Office Technical Guide practices will be used where necessary to prevent erosion and prevent off-site damage.
- Grading and shaping techniques will leave the soil in suitable enough condition to allow for seedbed preparation operations.
- Topsoil treatments will provide a minimum of 6 inches of cover.
- Permanent vegetative cover will be used on all sites with at least 75% of the horizontal electromagnetic induction meter (EM) readings less than 425 mS/m (millisiemens/meter).
- Sites with 50%-75% of the horizontal EM readings greater than 425 mS/m will require a combination of treatments.

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

Indiana NRCS FOTG – October 2015
Sites with 50% or less of the horizontal EM readings less than 425 mS/m are difficult to vegetate and will be treated by adding organic matter as indicated in Table 3.

Salt affected areas to be grazed with an adjoining pasture will be vegetated with grasses that have approximately the same palatability, maturity, and growth period.

Native plant species will be used whenever possible. Known invasive species will not be used.

All manufacturers’ label requirements will be followed when applying herbicides.

EM readings will be taken in the horizontal orientation. Maximum distance between EM readings will be based on the size of the area to be remediated. The maximum distances are found in Table 1.

**Table 1** – maximum distance for EM readings

<table>
<thead>
<tr>
<th></th>
<th>&lt;0.1 acre</th>
<th>0.1-0.5 acre</th>
<th>&gt;0.5 acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>5 meters</td>
<td>10 meters</td>
<td>20 meters</td>
</tr>
</tbody>
</table>

**Soil Amendments**

Prior to seeding, apply gypsum along with organic matter as indicated in Table 2. Incorporate to a depth of 3 inches.

Apply nitrogen at 50 lbs per acre. Apply phosphorus only if soil tests fall below 15 lbs. P/acre. Potassium fertilizers are not recommended for saline soils. Soil tests and the following table will be used to determine supplemental gypsum applications:

**Table 2** - Tons pure gypsum and organic material required

<table>
<thead>
<tr>
<th>mS/m</th>
<th>Gypsum (tons)</th>
<th>Organic Material (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-99</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100-150</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>151-250</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>251-350</td>
<td>4</td>
<td>2-3</td>
</tr>
<tr>
<td>351-450</td>
<td>5</td>
<td>4-5</td>
</tr>
<tr>
<td>451+</td>
<td>5</td>
<td>5 + soil *</td>
</tr>
</tbody>
</table>

* *4 to 6 inches of soil, suitable to grow vegetation, will be mixed in with the gypsum and organic material to augment a suitable medium.

**Organic Material**

Organic Material can include strawy manure, leaves, old hay, woodchips, and sawdust or like material approved by NRCS. Runoff and leaching potential will be evaluated when amendments include manure.

**Seedbed Preparation and Seeding**

Incorporate amendments with a disc or chisel plow. The seedbed will be firmed by rolling or harrowing prior to seeding. Seed may be applied using drill or broadcast methods.

Select species from Table 3. If needed, a barley companion crop will be seeded at 20 lbs per acre.

**Table 3** – suitable species for Saline/Sodic sites

<table>
<thead>
<tr>
<th>Species</th>
<th>Maximum EM (mS/m)</th>
<th>Minimum Plant Density (plants/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall Wheatgrass*</td>
<td>425</td>
<td>8</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>275</td>
<td>3</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>250</td>
<td>8</td>
</tr>
<tr>
<td>Winter Barley**</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Jose’ Tall wheatgrass has been found to be a good selection for Indiana.
** Winter Barley is utilized for a companion crop with the other species, not as a permanent seeding and utilized with all fall seedlings’.

Native plant species will be used whenever possible. Known invasive species will not be used.

The practice will be established to species of permanent grass, legumes and/or shrubs that accomplish the design objective, are adapted to the site, and do not function as hosts for field crop diseases or become a source of weeds in the crop field.

Seedbed preparation, species selection, seeding mixes, seeding rates, dates, depths, fertility requirements, site adaptation and planting methods will be consistent with the requirements in the IN NRCS Seeding Tool and/or Tables in Indiana (IN) Field Office Technical Guide (FOTG) Standard (342) Critical Area Seeding.
Criteria Applicable to Irrigated Lands

Soil electrical conductivity in the plant root zone will be measured to determine the depth of water application necessary for flushing accumulated salts and maintaining a proper salt balance.

The suitability of applied water for irrigation and leaching will be based on a representative water quality test report that includes electrical conductivity (EC), sodium adsorption ratio (SAR), and pH as well as the concentrations of the following individual constituents: calcium, magnesium, sodium, and sulfate concentrations.

The volume of irrigation water applied will include the leaching fraction necessary to maintain root zone salinity and sodium levels within acceptable levels for crops and for soil quality. Leaching fractions will be determined using methods in the National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements.

Criteria Applicable to Non-irrigated Lands

Reclamation will utilize vegetative methods, soil amendments, and/or enhanced drainage to effect a reduction in soil salinity.

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

For the root zone profile, soil tests from each quarter of the root zone will report electrical conductivity (EC); hydrogen ion concentration (pH); exchangeable sodium percentage (ESP); and ion concentrations of sodium, calcium, magnesium, and sulfate-sulfur. Ion concentrations will be determined from a saturated paste extract. Local conditions may indicate need for more exhaustive soil tests (e.g. potassium and potentially toxic ions).

The need for soil amendments to treat sodium affected soils will be based on the sodium adsorption ratio of the soil water extract. Soil amendments will be of a type that causes replacement of adsorbed soil sodium by calcium.

Application rates for soil amendments will be based on SAR soil test results from the depth of the root zone to be treated; the purity of the applied amendment; and quality of the irrigation water.

Criteria Specific to Saline Seeps and their Recharge Areas

Mitigation will include vegetative measures to reduce subsurface water and salt movement from the recharge area to the discharge area. Vegetative measures include establishment of deep rooted perennial crops such as wheatgrass and the deeper rooted cultivars of alfalfa.

The following measures will be applied to reduce subsurface water and salt movement to the seep outlet:

Establish deep-rooted, long season species in the recharge watershed area to utilize soil moisture and limit ground water movement to the seep area.

Remove ponded surface water from the recharge area before it percolates below the root zone.

Where practical, re-vegetation of the saline seep discharge area will be accomplished with species adapted to utilize excess soil moisture and to prevent upflux of water and salts.

CONSIDERATIONS

The considerations section contains information that is optional to the planner.

Tools such as electromagnetic induction (EMI), salinity probes (i.e. four electrode Wenner array), electrical conductivity instruments, and field soil test kits are appropriate for evaluating and for monitoring soil salinity levels.

Representative water chemistry reports for surface water sources may be available from USGS or from water districts.

Rigorous irrigation water quality tests for potassium, chloride, bicarbonate, and carbonate levels may be warranted in areas of high concern.

Consult published data for crop salt tolerances, and specific ion toxicities of crops for crop recommendations.

Local conditions and specific crop ion sensitivities may warrant water quality analysis for toxic salts (boron, chloride, etc.).

Sulfur or sulfuric acid applications enhance conversion of naturally occurring calcium carbonate to more soluble gypsum. Leaching should be delayed until the sulfur has oxidized and gypsum has formed.
Applications of a soluble calcium source such as gypsum in combination with irrigation leaching applications will help in displacing sodium from the root zone.

Seasonal changes in source water quality may require water quality evaluations at several times during the season of use.

Drainage water discharges may have high concentrations of salt. Select appropriate outlets and consider effects to surface water and groundwater.

Subsoiling for improvement of internal soil drainage may not be effective in soils of uniform texture/permeability, or if soils are not dry during subsoiling operations.

Avoid inversion tillage that can bring salinity to the surface and negate the leaching process.

Incorporation of green manure crops or organic matter into the soil can improve soil structure and permeability.

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

Salt tolerant crops with vigorous growing, fibrous root systems (e.g. sorghum, sudangrass) can increase the carbon dioxide content of the soil water, increasing the solubility of calcium carbonate to facilitate leaching of sodium.

For leaching of salts, water of slight to moderate salinity not dominated by sodium can be more effective than water of low salinity.

Crop 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.

Select crop bedding shapes and planting methods that reduce the concentration of salinity near the plant root zone, especially for germinating seeds.

Foliar damage can be an indicator of specific ion toxicities.

**PLANS AND SPECIFICATIONS**

Specifications for establishment and operation of this practice will be prepared for each field or treatment unit according to the Criteria described in this standard and will include the following items as applicable:

- Plan map showing location of:
  - Salinity/sodium affected areas
  - Saline seep recharge areas
  - Saline seep outlets or discharge areas.
- Geologic investigation showing:
  - Location (depth, extent) of materials contributing to salinity/sodicity on saline seep recharge areas
  - Impervious layers that cause hillside seeps.
- Soil tests required to determine current soil salinity/sodicity, plus previous test results to evaluate the effectiveness of the planned treatment and potential need for revision.
- Water tests required to determine suitability for irrigation and leaching.
- Leaching requirements for specific soils and crops, including the method and timing of water application.
- Required grading and shaping.
- Quantities and quality of soil amendments.
- Seeding mixtures and seeding dates according to NRCS IN FOTG Standard (342) Critical Area Seeding
- If grazed, use a prescribed grazing plan according to NRCS IN FOTG Standard (528) Prescribed Grazing.

**OPERATION AND MAINTENANCE**

An operation and maintenance plan will be provided to and reviewed with the landowner. The plan will include the following items and others as appropriate.

- Frequent inspections should be made to evaluate stand development during establishment and at least annually thereafter.
- Mow only if weeds compete with establishing vegetation. Allow established species to form and mature seeds.
- Any species, whose presence or overpopulation may jeopardize this practice, will be controlled. Spraying or other control methods will be done on a “spot” basis to protect forbs/legumes that benefit native pollinators and other wildlife.
• Top dress site with appropriate amendments when the vigor of the established species declines.

REFERENCES


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