United States Department of Agriculture

## CONSERVATION ENHANCEMENT ACTIVITY

## E328H

CONSERVATION STEWARDSHIP PROGRAM

# Conservation crop rotation to reduce the concentration of salts

### Conservation Practice 328: Conservation Crop Rotation

**APPLICABLE LAND USE: Crop (Annual & Mixed)**

**RESOURCE CONCERN: Soil**

**ENHANCEMENT LIFE SPAN: 1 Year**

**Enhancement Description**

Implement a crop rotation to reduce the concentration of salts and other chemicals from saline seeps. The rotation should include at least 3 crops and/or cover crops grown in a sequence in the recharge areas of saline seeps that have rooting depths and water requirements adequate to fully utilize all available soil water. Do not use summer fallow. Use an approved water balance procedure to determine crop selection and sequence. Select crops with a tolerance to salinity levels that match the salinity of the discharge area. (See state lists)

**Criteria**

- Crops shall be grown in a planned sequence as outlined in plan. The crop rotation must include a minimum of three different crops. For purposes of these criteria a cover crop is considered a different crop.
- Where applicable, plan suitable crop substitutions when the planned crop cannot be planted due to weather, soil conditions, or other local situations.
- Select crops to be grown in the recharge area of saline seeps that have rooting depths and water requirements adequate to fully utilize all available soil water.

CONSERVATION STEWARDSHIP PROGRAM

- Do not use summer fallow.
- Use an approved water balance procedure to determine crop selection and sequence.
- If excess subsoil moisture exists below the rooting depth of crops commonly grown in the recharge area, establish deep-rooted perennial crops for the number of years needed to dry the soil profile.
- Select crops with a tolerance to salinity levels that match the salinity of the discharge area. (**See State list of salt tolerant crops with rooting depths and water requirements adequate to use all available soil water.**)

CONSERVATION STEWARDSHIP PROGRAM

**Documentation and Implementation Requirements**

**Participant will:**

☐ Prior to implementation, complete the following table and use an approved water balance procedure to determine crop selection and sequence.

**Planned Management Rotation (Do not use summer fallow):**

| Field | Planned Crops (in sequence) | Planting Date | Harvest or Termination Date | Crop Rooting Depth (inches) | Crop Water Requirements |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

☐ During implementation, notify NRCS of any planned changes in crops, crop rotation, or field operations to verify the planned system meets the enhancement criteria.

☐ After implementation, if changes to the rotation were made, complete the table above to document the applied crop rotation for the contract period and provide to NRCS.

**NRCS will:**

☐ As needed, provide technical assistance using an approved water balance procedure in selecting crop rotations or substitute crops that would meet the criteria of the enhancement.

☐ Prior to implementation, verify that the crop rotation includes at least three different crops in rotation.

☐ Prior to implementation, verify the crop rotation has a water balance to verify crops selected and sequence is adequate.

☐ During implementation, evaluate planned changes to verify the planned system meets the enhancement criteria.

☐ After implementation, if the applied crop rotation is different than the planned crop rotation, verify the implemented rotation meets the enhancement criteria.

**NRCS Documentation Review:**

CONSERVATION STEWARDSHIP PROGRAM

I have reviewed all required participant documentation and have determined the participant has implemented the enhancement and met all criteria and requirements.

Participant Name _____ Contract Number _____

Total Amount Applied _____ Fiscal Year Completed _____

_____ _____

NRCS Technical Adequacy Signature Date

CONSERVATION STEWARDSHIP PROGRAM

# IDAHO SUPPLEMENT TO

# CONSERVATION ENHANCEMENT

# ACTIVITY E328H

**Additional Criteria for Idaho**

- For a list of crop rooting depths and water requirements please contact your local NRCS field office. NRCS field office staff can find crop rooting depths and water requirements in chapters 4 and 9 of the Idaho Irrigation Guide. The Idaho Irrigation Guide is a supplement to the National Engineering Handbook (NEH) Part 652. An electronic copy of the Idaho Irrigation guide can be found on the Idaho Engineering share point site.

- Ch. 4 Consumptive use data:
  (you will have to download "652 Idaho Supplement to Chapter 4 CU graphs" first)
  https://usdagcc.sharepoint.com/sites/nrcs_idaho/engr/handbooks/SitePages/Home.aspx?RootFolder=%2Fsites%2Fnrcs%5Fidaho%2Fengr%2Fhandbooks%2FShared%20Documents%2FNEH%2FPart%20652%2FIdaho%20Supplements%2FNotice%205%20Idaho%20Consumptive%20Use&FolderCTID=0x01200016F9D4F5D04350409AFFD28169D58269&View=%7B9C5B3576%2DBFCA%2D4EC1%2DBCAB%2D1A330257E635%7D

- Ch. 9 Crop Consumptive Use Curves (Includes Crop rooting depths and management allowable Deficit) – Must select the appropriate Idaho Crop Zone:
  https://usdagcc.sharepoint.com/sites/nrcs_idaho/engr/handbooks/SitePages/Home.aspx?RootFolder=%2Fsites%2Fnrcs%5Fidaho%2Fengr%2Fhandbooks%2FShared%20Documents%2FNEH%2FPart%20652%2FIdaho%20Supplements%2FNotice%207%20Consumptive%20Use%20Curves&FolderCTID=0x01200016F9D4F5D04350409AFFD28169D58269&View=%7B9C5B3576%2DBFCA%2D4EC1%2DBCAB%2D1A330257E635%7D

**Additional Documentation Requirements for Idaho**

- A list of tolerances of various crops to salts is attached to the end of this enhancement supplement. Use this list to determine which crops can be used in your rotation to reduce salts as per the conservation crop rotation 328 conservation practice standard "additional criteria" for managing saline seeps. This list comes from the NRCS national engineering handbook (NEH) part 652; ch. 13; table 13-1.

- Implementation of this enhancement must meet all "general criteria" and "additional criteria related to the applicable practice purpose" listed in the NRCS conservation practice standard for the conservation crop rotation (328) practice.

- Crop rotation must be documented using the current Idaho 328 specification.

**Table 13–3** Salt tolerance of selected crops [1/]

| Common name | Botanical name | Salt tolerance threshold [2/] ($EC_t$) | Yield decline [3/] ($Y_d$) | Qualitative salt tolerance rating [4/] |
|---|---|---|---|---|
| | | mmho/cm | % per mmho/cm | |
| **Field crops** | | | | |
| Barley | *Hordeum vulgare* | 8.0 | 5.0 | T |
| Bean | *Phaseolus vulgaris* | 1.0 | 19 | S |
| Broad bean | *Vicia faba* | 1.6 | 9.6 | MS |
| Corn | *Zea Mays* | 1.7 | 12 | MS |
| Cotton | *Gossypium hirsutum* | 7.7 | 5.2 | T |
| Cowpea | *Vigna unguiculata* | 4.9 | 12 | MT |
| Flax | *Linum usitatissimum* | 1.7 | 12 | MS |
| Guar | *Cyamopsis tetragonoloba* | 8.8 | 17.0 | T |
| Millet, foxtail | *Setaria italica* | — | — | MS |
| Oats | *Avena sativa* | — | — | MT |
| Peanut | *Arachis hypogaea* | 3.2 | 29 | MS |
| Rice, paddy [5/] | *Oryza sativa* | 3.0 | 12 | S |
| Rye | *Secale cereale* | 11.4 | 10.8 | T |
| Safflower | *Carthamus tinctorius* | — | — | MT |
| Sesame | *Sesamum indicum* | — | — | S |
| Sorghum | *Sorghum bicolor* | 6.8 | 16 | MT |
| Soybean | *Glycine max* | 5.0 | 20 | MT |
| Sugar beet | *Beta vulgaris* | 7.0 | 5.9 | T |
| Sugarcane | *Saccharum officinarum* | 1.7 | 5.9 | MS |
| Sunflower | *Helianthus annuus* | — | — | MS |
| Triticale | *x Triticosecale* | 6.1 | 2.5 | T |
| Wheat | *Triticum aestivum* | 6.0 | 7.1 | MT |
| Wheat (semidwarf) | *T. aestivum* | 8.6 | 3.0 | T |
| Wheat, durum | *T. turgidum* | 5.9 | 3.8 | T |
| **Grasses and forage crops** | | | | |
| Alfalfa | *Medicago sativa* | 2.0 | 7.3 | MS |

| | | | | |
|---|---|---|---|---|
| Alkaligrass, nuttall | *Puccinellia airoides* | — | — | T |
| Alkali sacaton | *Sporobolus airoides* | — | — | T |
| Barley (forage) | *Hordeum vulgare* | 6.0 | 7.1 | MT |
| Bentgrass | *Agrostis stolonifera palustris* | — | — | MS |
| Bermudagrass | *Cynodon dactylon* | 6.9 | 6.4 | T |
| Bluestem, angleton | *Dichanthium aristatum* | — | — | MS |
| Brome, mountain | *Bromus marginatus* | — | — | MT |
| Brome, smooth | *B. inermis* | — | — | MS |
| Buffelgrass | *Cenchrus ciliaris* | — | — | MS |
| Burnet | *Poterium sanguisorba* | — | — | MS |
| Canarygrass, reed | *Phalaris arundinacea* | — | — | MT |

See footnotes at end of table.

**Table 13–3** Salt tolerance of selected crops[1/]—Continued

| Common name | Botanical name | Salt threshold [2/] ($EC_t$) | Yield Qualitative tolerance decline [3/] ($Y_d$) | salt tolerance rating [4/] |
|---|---|---|---|---|
| | | mmho/cm | % per mmho/cm | |
| **Grasses and forage crops** (continued) | | | | |
| Clover, alsike | *Trifolium hybridum* | 1.5 | 12 | MS |
| Clover, berseem | *T. alexandrinum* | 1.5 | 5.7 | MS |
| Clover, hubam | *Melilotus alba* | — | — | MT |
| Clover, ladino | *Trifolium repens* | 1.5 | 12 | MS |
| Clover, red | *T. pratense* | 1.5 | 12 | MS |
| Clover, strawberry | *T. fragiferum* | 1.5 | 12 | MS |
| Clover, sweet | *Melilotus* | — | — | MT |
| Clover, white Dutch | *Trifolium repens* | — | — | MS |
| Corn (forage) | *Zea mays* | 1.8 | 7.4 | MS |
| Cowpea (forage) | *Vigna unguiculata* | 2.5 | 11 | MS |
| Dallisgrass | *Paspalum dilatatum* | — | — | MS |
| Fescue, tall | *Festuca elatior* | 3.9 | 5.3 | MT |
| Fescue, meadow | *F. pratensis* | — | — | MT |
| Foxtail, meadow | *Alopecurus pratensis* | 1.5 | 9.6 | MS |
| Grama, blue | *Bouteloua gracilis* | — | — | MS |
| Hardinggrass | *Phalaris tuberosa* | 4.6 | 7.6 | MT |
| Kallar grass | *Diplachne fusca* | — | — | T |
| Lovegrass | *Eragrostis sp.* | 2.0 | 8.4 | MS |
| Milkvetch, cicer | *Astragalus cicer* | — | — | MS |
| Oatgrass, tall | *Arrhenatherum, Danthonia* | — | — | MS |
| Oats (forage) | *Avena sativa* | — | — | MS |
| Orchardgrass | *Dactylis glomerata* | 1.5 | 6.2 | MS |
| Panicgrass, blue | *Panicum antidotale* | — | — | MT |
| Rape | *Brassica napus* | — | — | MT |

| | | | | |
|---|---|---|---|---|
| Rescuegrass | *Bromus unioloides* | — | — | MT |
| Rhodesgrass | *Chloris gayana* | — | — | MT |
| Rye (forage) | *Secale cereale* | — | — | MS |
| Ryegrass, Italian | *Lolium italicum multiflorum* | — | — | MT |
| Ryegrass, perennial | *L. perenne* | 5.6 | 7.6 | MT |
| Saltgrass, desert | *Distichlis stricta* | — | — | T |
| Sesbania | *Sesbania exaltata* | 2.3 | 7.0 | MS |
| Siratro | *Macroptilium atropurpureum* | — | — | MS |
| Sphaerophysa | *Sphaerophysa salsula* | 2.2 | 7.0 | MS |
| Sudangrass | *Sorghum sudanense* | 2.8 | 4.3 | MT |
| Timothy | *Phleum pratense* | — | — | MS |
| Trefoil, big | *Lotus uliginosus* | 2.3 | 19 | MS |
| Trefoil, narrowleaf birdsfoot | *L. corniculatus tenuifolium* | 5.0 | 10 | MT |
| Trefoil, broadleaf birdsfoot | *L. corniculatus arvenis* | — | — | MT |

See footnotes at end of table.

**Table 13–3** Salt tolerance of selected crops[1/]—Continued

| Common name | Botanical name | Salt threshold[2/] ($EC_t$) | Yield Qualitative decline[3/] ($Y_d$) | tolerance salt tolerance rating[4/] |
|---|---|---|---|---|
| | | mmho/cm | % per mmho/cm | |
| **Grasses and forage crops** (continued) | | | | |
| Vetch, common | *Vicia angustifolia* | 3.0 | 11 | MS |
| Wheat (forage) | *Triticum aestivum* | 4.5 | 2.6 | MT |
| Wheat, durum (forage) | *T. turgidum* | 2.1 | 2.5 | MT |
| Wheatgrass, standard crested | *Agropyron sibiricum* | 3.5 | 4.0 | MT |
| Wheatgrass, fairway crested | *A. cristatum* | 7.5 | 6.9 | T |
| Wheatgrass, intermediate | *A. intermedium* | — | — | MT |
| Wheatgrass, slender | *A. trachycaulum* | — | — | MT |
| Wheatgrass, tall | *A. elongatum* | 7.5 | 4.2 | T |
| Wheatgrass, western | *A. smithii* | — | — | MT |
| Wildrye, Altai | *Elymus angustus* | — | — | T |
| Wildrye, beardless | *E. triticoides* | 2.7 | 6.0 | MT |
| Wildrye, Canadian | *E. canadensis* | — | — | MT |
| Wildrye, Russian | *E. junceus* | — | — | T |
| **Vegetable and fruit crops** | | | | |
| Artichoke | *Helianthus tuberosus* | — | — | MT |
| Asparagus | *Asparagus officinalis* | 4.1 | 2.0 | T |
| Bean | *Phaseolus vulgaris* | 1.0 | 19 | S |
| Beet, red | *Beta vulgaris* | 4.0 | 9.0 | MT |
| Broccoli | *Brassica oleracea botrytis* | 2.8 | 9.2 | MS |
| Brussels sprouts | *B. oleracea gemmifera* | — | — | MS |
| Cabbage | *B. oleracea capitata* | 1.8 | 9.7 | MS |
| Carrot | *Daucus carota* | 1.0 | 14 | S |

| | | | | |
|---|---|---|---|---|
| Cauliflower | *B. oleracea botrytis* | — | — | MS |
| Celery | *Apium graveolens* | 1.8 | 6.2 | MS |
| Corn, sweet | *Zea mays* | 1.7 | 12 | MS |
| Cucumber | *Cucumis sativus* | 2.5 | 13 | MS |
| Eggplant | *Solanum melongena esculentum* | 1.1 | 6.9 | MS |
| Kale | *B. oleracea acephala* | — | — | MS |
| Kohlrabi | *B. oleracea gongylodes* | — | — | MS |
| Lettuce | *Lactuca sativa* | 1.3 | 13 | MS |
| Muskmelon | *Cucumis melo* | — | — | MS |
| Okra | *Abelmoschus esculentus* | — | — | S |
| Onion | *Allium cepa* | 1.2 | 16 | S |
| Parsnip | *Pastinaca sativa* | — | — | S |
| Pea | *Pisum sativum* | — | — | S |
| Pepper | *Capsicum annuum* | 1.5 | 14 | MS |
| Potato | *Solanum tuberosum* | 1.7 | 12 | MS |

See footnotes at end of table.

**Table 13–3** Salt tolerance of selected crops[1/]—Continued

| Common name | Botanical name | Salt threshold [2/] ($EC_t$) | Yield Qualitative decline [3/] ($Y_d$) | tolerance salt tolerance rating [4/] |
|---|---|---|---|---|
| | | mmho/cm | % per mmho/cm | |
| **Vegetable and fruit crops** (continued) | | | | |
| Pumpkin | *Cucurbita pepo pepo* | — | — | MS |
| Radish | *Raphanus sativus* | 1.2 | 13 | MS |
| Spinach | *Spinacia oleracea* | 2.0 | 7.6 | MS |
| Squash, scallop | *Cucurbita pepo melopepo* | 3.2 | 16 | MS |
| Squash, zucchini | *C. pepo melopepo* | 4.7 | 9.4 | MT |
| Strawberry | *Fragaria sp.* | 1.0 | 33 | S |
| Sweet potato | *Ipomoea batatas* | 1.5 | 11 | MS |
| Tomato | *Lycopersicon lycopersicum* | 2.5 | 9.9 | MS |
| Turnip | *Brassica rapa* | 0.9 | 9.0 | MS |
| Watermelon | *Citrullus lanatus* | — | — | MS |
| **Woody crops** | | | | |
| Almond | *Prunus dulcis* | 1.5 | 19 | S |
| Apple | *Malus sylvestris* | — | — | S |
| Apricot | *P. armeniaca* | 1.6 | 24 | S |
| Avocado | *Persea americana* | — | — | S |
| Blackberry | *Rubus sp.* | 1.5 | 22 | S |
| Boysenberry | *Rubus ursinus* | 1.5 | 22 | S |
| Castor bean | *Ricinus communis* | — | — | MS |
| Cherimoya | *Annona cherimola* | — | — | S |
| Cherry, sweet | *Prunus avium* | — | — | S |
| Cherry, sand | *P. besseyi* | — | — | S |
| Currant | *Ribes sp.* | — | — | S |

| | | | | |
|---|---|---|---|---|
| Date palm | *Phoenix dactylifera* | 4.0 | 3.6 | T |
| Fig | *Ficus carica* | — | — | MT |
| Gooseberry | *Ribes sp.* | — | — | S |
| Grape | *Vitis sp.* | 1.5 | 9.6 | MS |
| Grapefruit | *Citrus paradisi* | 1.8 | 16 | S |
| Guayule | *Partheniu m argentatum* | 8.7 | 11.6 | T |
| Jojoba | *Simmondsia chinensis* | — | — | T |
| Jujube | *Zizi phus jujuba* | — | — | MT |
| Lemon | *C. limon* | — | — | S |
| Lime | *C aurantiifolia* | — | — | S |
| Loquat | *Eriobotrya japonica* | — | — | S |
| Mango | *Mangifera indica* | — | — | S |
| Olive | *Olea europaea* | — | — | MT |
| Orange | *C. sinensis* | 1.7 | 16 | S |
| Papaya | *Carica papaya* | — | — | MT |

See footnotes at end of table.

**Table 13–3** Salt tolerance of selected crops[1/]—Continued

| Common name | Botanical name | Salt threshold[2/] ($EC_t$) | Yield decline[3/] ($Y_d$) | Qualitative salt tolerance rating[4/] |
|---|---|---|---|---|
| | | mmho/cm | % per mmho/cm | |
| **Woody crops** (continued) | | | | |
| Passion fruit | *Passiflora edulis* | — | — | S |
| Peach | *Prunus persica* | 1.7 | 21 | S |
| Pear | *Pyrus communis* | — | — | S |
| Persimmon | *Diospyros virginiana* | — | — | S |
| Pineapple | *Ananas comosus* | — | — | MT |
| Plum; prune | *Prunus domestica* | 1.5 | 18 | S |
| Pomegranate | *Punica granatum* | — | — | MT |
| Pummelo | *Citrus maxima* | — | — | S |
| Raspberry | *Rubus idaeus* | — | — | S |
| Rose apple | *Syzygium jambos* | — | — | S |
| Sapote, white | *Casimiroa edulis* | — | — | S |
| Tangerine | *Citrus reticulata* | — | — | S |

1/ Adapted from Maas and Hoffman (1977) and Maas (1990). Data serve as a guide to relative tolerances. Absolute tolerances depend upon climate, soil conditions, and culturalpractices. Note: 1 mmho/cm = 1 dS/m.

2/ Salt tolerance threshold ($EC_t$) is the mean soil salinity at initial yield decline. Salinity expressed as $EC_e$ in mmho/cm referenced to 77 °F (25 °C).

3/ Percent yield decline ($Y_d$) is the rate of yield reduction per unit increase in salinity beyond the threshold.

4/ Qualitative salt tolerance ratings are sensitive (S), moderately sensitive (MS), moderately tolerant (MT), and tolerant (T) as shown in figure 2–32.

5/ Values are for soil-water while plants are submerged. Less tolerant during seedling stage.