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# Yield and Quality of Perennial Cool-Season Grasses on Saline Soils in the Northern Great Plains



*Helping People Help the Land*

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# Acknowledgements

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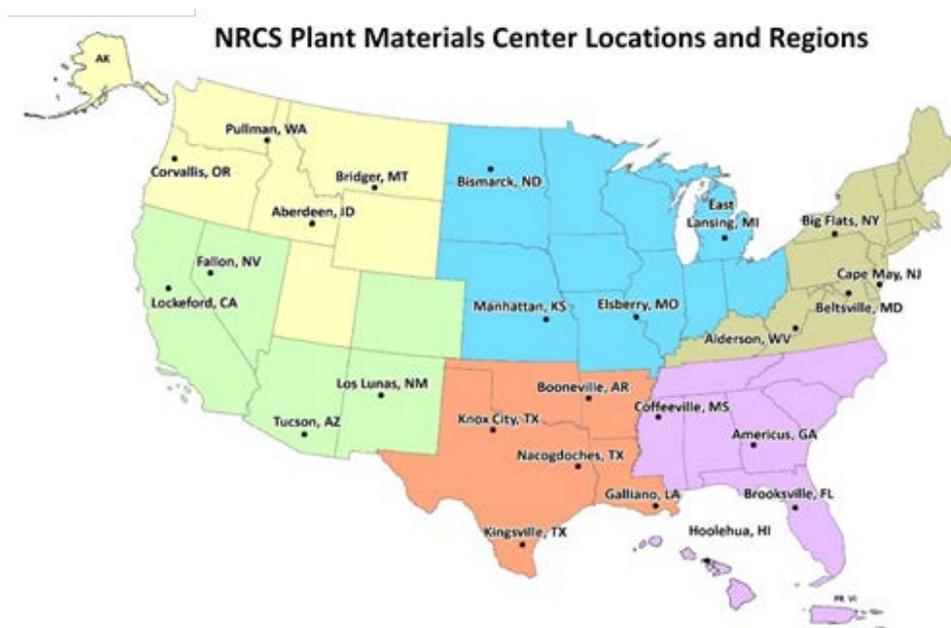
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# Preface

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The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the evaluation of conservation plants and planting technology for more than 75 years. Land use changes from grassland to annual tillage and cropping practices have contributed to increasing acreages of land negatively impacted by soil salinity. This evolution has resulted in lost productivity and erosion concerns for impacted soils. Based on these concerns, the Bismarck Plant Materials Center participated with the Carrington Research Extension Center in a field trial to evaluate salinity tolerance and forage quality of several perennial cool-season grasses considered to be somewhat or highly saline tolerant. This study was implemented to provide perennial grass cover options for minimizing saline impacts and improving productivity of affected soils.

For additional information on specific species of plants mentioned in this publication, please see the USDA PLANTS database at: (<http://plants.usda.gov/java/>) or contact the nearest Plant Materials Center or plant materials specialist (<http://plant-materials.nrcs.usda.gov/contact/>) and/or the Land Grant Universities that serves the State. For specific information on soils and soil health, please see USDA NRCS soils website at: (<http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/>). Also, see technical resources on the National Plant Materials Program Web site at: (<http://www.plant-materials.nrcs.usda.gov/>).



## Grass Performance on Saline Soils at Carrington and Buchanan, North Dakota

Roughly six million acres (approximately 13%) of North Dakota soils are considered saline (Fig. 1). Producers and landowners who manage land impacted by saline soils are concerned with losses in production and continued expansion of acreage impacted by salinity. Large acreages of perennial grasses and forbs that once covered the prairie are now producing annual crops. Cropping systems have shifted over the last 30-40 years from mostly fallow/small grain rotations to traditional diverse crop rotations with 5-7 crops, and most recently to rotations dominated primarily by two or three crops. The changes in land use have affected water management resulting in continued expansion of saline-impacted soils.

Management of saline-impacted soils using cultivation and/or traditional cropping rarely addresses the problem. Continuing these practices often results in further expansion of the saline area and additional losses in production and income. Typically, the vegetation in saline areas transitions to kochia (*Kochia scoparia* L.) and foxtail barley (*Hordeum jubatum* L.). Perennial forage grasses are often the best alternative to annual crop production for utilizing and reclaiming these areas. Grasses provide continuous ground cover, forage for livestock, and habitat for wildlife. They improve the physical structure of the soil



Figure 1. Salt-affected land impacts ~ 6 million acres in North Dakota.

and improve water infiltration. Saline soils are difficult to reclaim and make productive. Saline concentrations are often too high to establish or maintain vegetation. Reduced soil disturbance and establishment of deep-rooted plants are effective tools for addressing the wide array of salinity issues found across the region. Management strategies using these tools, along with a list of tolerant plant species for saline sites is available in the publication; [Plant Materials for Salt-Affected Sites in the Northern Great Plains](#). It was developed by the USDA-NRCS Bismarck, North Dakota Plant Materials Center (PMC) using information obtained from long-term perennial grass field evaluation plantings on saline sites in North Dakota, South Dakota and Minnesota, and through published literature.

To expand the current list of salt tolerant forages, the PMC cooperated in a five-year study to evaluate cool-season grasses across a known salinity gradient near Carrington and Buchanan, North Dakota. Seed of each cool-season grass cultivar was drilled in late May and early June 2010 into a Hamerly-Svea and Svea-Barnes loam at Buchanan and a Vallers-Hamerly and Heimdal-Esmond loam at Carrington with an electrical conductivity (EC) range of 3 to 21dS/m (Table 1). Grasses were clipped annually the 2<sup>nd</sup> week of July when most were physiologically mature. The clipping dates correspond to a time when similar saline sites would be dry enough to cut for hay (Fig. 2). Temperature and rainfall summaries at Carrington and Buchanan are reported in Table 4.

This technical note reports productivity and forage quality estimates of 11 cool-season grass cultivars from 2011-2015 at Carrington and Buchanan (Fig 3-5). Table 2 summarizes the

performance of the cool-season grasses for forage quality and biomass production over varying salinity ranges. Table 3 provides forage quality estimates of crude protein, total digestible nutrients and a relative feed value of the cool-season grasses at both sites. Results of this study strengthen NRCS critical area planting specifications by providing additional cool-season grass species for salt-affected land while providing a quality forage for livestock production in the northern Great Plains.

## Summary

Saline discharge soils are best suited for perennial, salt tolerant grasses due to their ability to improve infiltration and use excess water. Perennial grasses enhance the movement of salts deeper into the soil profile and away from the root zone. Cool-season grasses provide ground cover and good quality forage when established in saline soil conditions. The tested cultivars displayed varying levels of salt tolerance. 'Lincoln' smooth brome grass, 'Fleet' meadow brome grass and 'Garrison' creeping foxtail performed well in EC 6.5-7.0 dS/m. 'Mandan' Canada wildrye is an early-season grass that had respectable forage production to EC 7 dS/m. 'Shoshone' manystem wildrye produced respectable yields of high quality forage to EC 10 dS/m. Tall, slender, and western wheatgrasses are easy to establish and have been widely and historically recommended for saline areas. Yields for these wheatgrasses were respectable to EC 12 dS/m at both Buchanan and Carrington, North Dakota. Although tall wheatgrass generally produces abundant forage and cover for livestock and wildlife habitat, it has the poorest quality. 'AC Saltlander' and 'NewHy' hybrid wheatgrass provided very stable yields of high quality forage to EC 14 dS/m. These, along with tall wheatgrass, continue to maintain very thick stands with no sign of plant mortality. Maintaining permanent cover of perennial grasses is key to improving saline conditions in the Northern Great Plains.



Figure 2. Clipping cool-season grasses established on a saline gradient at Carrington, North Dakota.

Table 1. Cool-season grass cultivars and seeding rates at Carrington and Buchanan, North Dakota.

Common Name	Species	Cultivar	Seeding Rate <sup>1/</sup> (PLS lbs/acre)
green wheatgrass	<i>Elymus hoffmannii</i>	‘AC Saltlander’	15.00
tall wheatgrass	<i>Thinopyrum ponticum</i>	‘Alkar’	20.25
meadow brome	<i>Bromus biebersteinii</i>	‘Fleet’	24.75
‘Saltlander’ forage mix <sup>2/</sup>	MIX	MIX	30.00
creeping foxtail	<i>Alopecurus arundinaceus</i>	‘Garrison’	5.25
smooth brome	<i>Bromus inermis</i>	‘Lincoln’	12.00
Canada wildrye	<i>Elymus canadensis</i>	‘Mandan’	11.25
hybrid wheatgrass	<i>Elymus hoffmannii</i>	‘NewHy’	21.00
slender wheatgrass	<i>Elymus trachycaulus</i>	‘Revenue’	8.25
western wheatgrass	<i>Pascopyrum smithii</i>	‘Rodan’	15.00
manystem wildrye	<i>Leymus multicaulis</i>	‘Shoshone’	12.75

<sup>1/</sup> Seeding rates are based on NRCS North Dakota Field Office Technical Guide Critical Area Planting rates (Practice Standard 342), which are 1.5 times the standard full seeding rate for MLRA 55B.

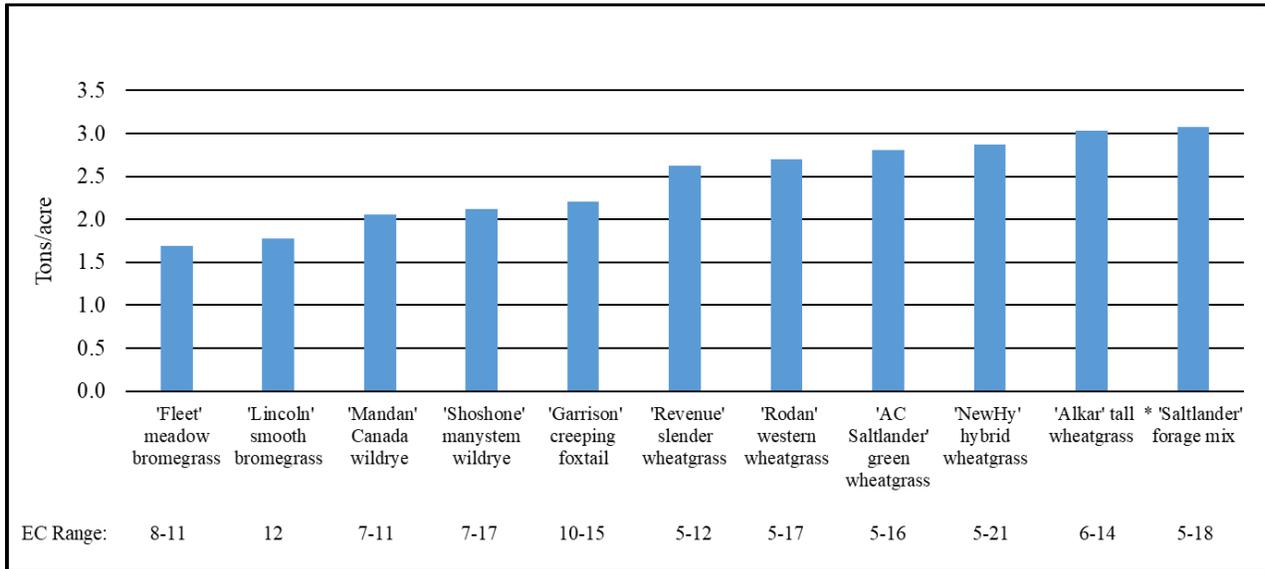
<sup>2/</sup> ‘Saltlander’ forage mix consists of 50% ‘AC Saltlander,’ 25% ‘Revenue’ slender wheatgrass, 25% ‘Courtney’ tall fescue.

Table 2. Summary of saline tolerance, forage quality, and biomass production of cool-season grasses evaluated on a known salinity gradient at Carrington and Buchanan, North Dakota.

Cultivar/Common Name	Salinity Tolerance	Highest Salinity Range (dS/m)	Forage Quality	Biomass
‘NewHy’ hybrid wheatgrass	High	8.0-9.5	Good	Very Good
‘Alkar’ tall wheatgrass	High	8.0-9.5	Very Poor	Very Good
‘Shoshone’ manystem wildrye	High	8.0-9.5	Poor	Good
‘AC Saltlander’ green wheatgrass	High	8.0-9.5	Very Good	Very Good
‘Saltlander’ forage mix <sup>1/</sup>	Medium High	7.5-9.0	Very Good	Very Good
‘Rodan’ western wheatgrass	Medium High	7.5-9.0	Fair	Good
‘Garrison’ creeping foxtail	Medium	6.0-8.5	Fair	Good
‘Revenue’ slender wheatgrass	Medium	6.0-8.5	Poor	Good
‘Lincoln’ smooth brome	Slight	5.5-7.0	Very Good	Fair
‘Mandan’ Canada wildrye	Slight	5.5-7.0	Fair	Good
‘Fleet’ meadow brome	Slight	5.5-7.0	Good	Fair

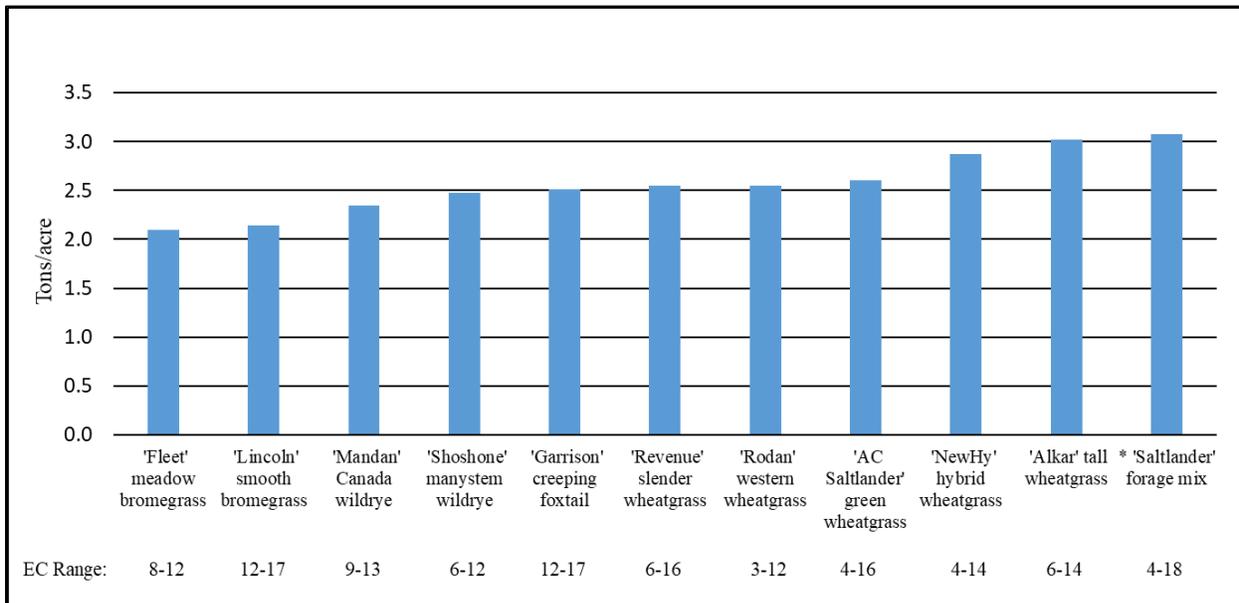
<sup>1/</sup> ‘Saltlander’ forage mix consists of 50% ‘AC Saltlander’, 25% ‘Revenue’ slender wheatgrass, 25% ‘Courtney’ tall fescue.

Figure 3. Average 5-year forage production and EC (dS/m) ranges of cool-season grasses planted at Buchanan, North Dakota.



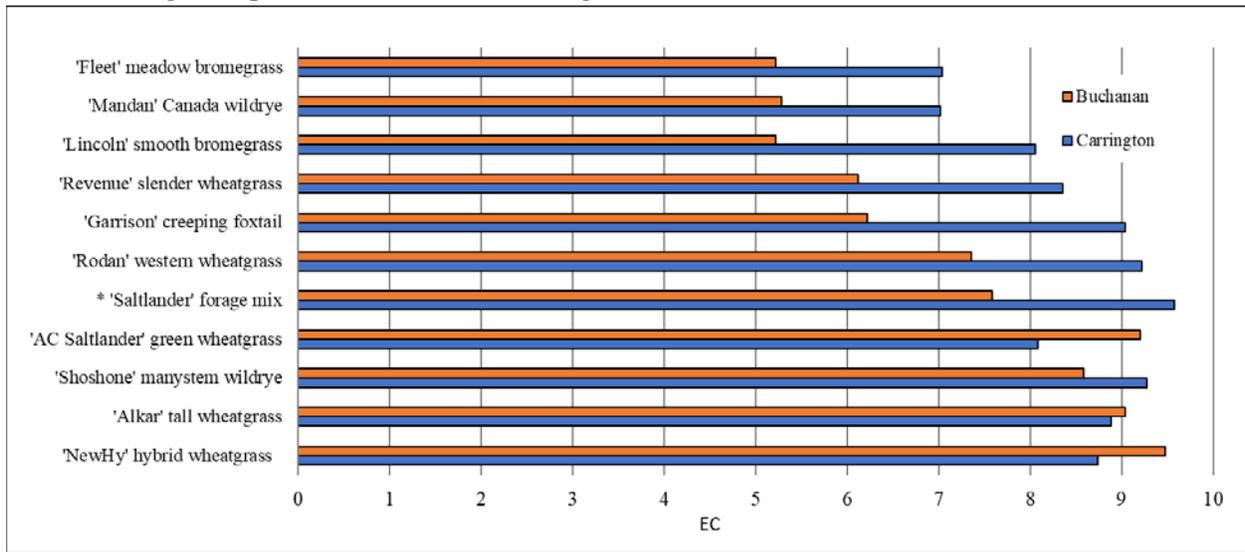
\*'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Figure 4. Average 5-year forage production and EC (dS/m) ranges of cool-season grasses planted at Carrington, North Dakota.



\*'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Figure 5. Salinity tolerance based on the average of the five highest EC (dS/m) levels for each cool-season grass species evaluated at Carrington and Buchanan, North Dakota.



\*'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Table 3. Three-year average forage quality estimates of cool-season grass cultivars harvested near maturity on saline sites at Buchanan and Carrington, North Dakota, 2013-2015.

Cultivar	Buchanan			Carrington		
	CP <sup>1/</sup>	TDN <sup>2/</sup>	RFV <sup>3/</sup>	CP	TDN	RFV
	-----%-----					
'AC Saltlander' green wheatgrass	6	57	87	7	57	86
'Alkar' tall wheatgrass	6	49	67	7	49	67
'Fleet' meadow brome	6	59	84	6	58	85
'Saltlander' forage mix <sup>4/</sup>	7	57	85	8	57	86
'Garrison' creeping foxtail	6	54	82	5	53	80
'Lincoln' smooth brome	6	57	87	5	57	88
'Mandan' Canada wildrye	6	55	78	6	55	80
'NewHy' hybrid wheatgrass	6	57	86	6	56	84
'Revenue' slender wheatgrass	6	54	73	7	54	74
'Rodan' western wheatgrass	7	58	84	7	56	81
'Shoshone' manystem wildrye	8	54	77	7	52	72

<sup>1/</sup>crude protein, <sup>2/</sup>total digestible nutrients; <sup>3/</sup>relative feed value; <sup>4/</sup>'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Table 4. Temperature and precipitation data for saline study plots at Carrington and Buchanan, North Dakota.

Year	Buchanan <sup>1/</sup>			Carrington <sup>2/</sup>		
	Avg. Annual Temp. -----F <sup>0</sup> -----	Apr.-Jun. Avg. Temp.	Total Annual Precip. --inches--	Avg. Annual Temp. -----F <sup>0</sup> -----	Apr.-Jun. Avg. Temp.	Total Annual Precip. --inches--
2009	39.7	55.5	14.1	38.2	50.6	18.7
2010	42.0	58.2	28.3	41.0	55.3	23.7
2011	42.3	56.2	23.1	40.2	50.7	28.2
2012	45.7	60.8	12.9	44.0	55.9	16.6
2013	40.8	58.4	19.9	38.6	48.3	12.6
2014	41.0	58.2	23.9	38.2	51.3	11.0
2015	44.4	57.6	30.8	43.1	54.9	16.5
Avg	42.3	57.8	21.9	40.5	52.4	18.2

<sup>1/</sup>data from Jamestown, North Dakota Airport weather station, <sup>2/</sup>data from Carrington 4N NDAWN weather station.