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COOL-SEASON GRASS PERFORMANCE ON SALINE SOILS IN THE NORTHERN GREAT PLAINS



Saline site near Carrington, North Dakota prior to perennial cool-season grass establishment.



Saline site near Carrington, North Dakota five years after perennial cool-season grass establishment.

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GRASS PERFORMANCE ON SALINE SOILS (*Carrington, North Dakota; Buchanan, North Dakota*)

Roughly six million acres (approximately 13%) of North Dakota soils are considered saline. 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 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 and 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 with the NDSU Carrington Research Extension Center in a field trial that evaluated 11 cool-season grasses (Table 1) across a salinity gradient, with electrical conductivity EC ranging from 3 to 21dS/m. The EC_(1:1) was measured using a hand-held meter. Field plots were at Carrington and Buchanan, North Dakota. The soils include Vallers-Fram and Heimdal-Esmond loam soils at Carrington, and Hamerly-Wyard and Barnes-Svea loam soils at Buchanan. Plots were seeded in 2010 and forage was evaluated annually from 2011-2015. Grasses were clipped in the 2nd week of July when most were physiologically mature. The clipping dates correspond to a time when similar saline sites would be dry enough to harvest. Temperature and precipitation for each field site can be found in Table 2.



Clipping cool-season grasses growing on saline soils at the Carrington, North Dakota site.

Productivity and forage quality estimates for each grass are shown in Fig. 1-3 and Table 3. The results strengthen NRCS critical area planting specifications by offering additional cool-season grass species for salt-affected land. These grasses provide quality forage for livestock production in the northern Great Plains. Table 4 summarizes the performance of the cool-season grasses for forage quality and biomass production over varying salinity ranges.

CONCLUSIONS

- 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 can provide ground cover and good quality forage when established in saline soils. The tested cultivars displayed varying levels of salt tolerance.
- 'Lincoln' smooth bromegrass, 'Fleet' meadow bromegrass 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.



'Shoshone' manystem wildrye vigorously growing in saline soil.

- 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 12dS/m at both Buchanan and Carrington, North Dakota.
- Although tall wheatgrass generally produces abundant forage and cover for livestock and wildlife habitat, it has poorer quality than other species tested.
- 'AC Saltlander' and 'NewHy' hybrid wheatgrass provided 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.
- Saline discharge soils like those in this study are best suited for perennial, salt tolerant grasses. Perennial vegetation improves infiltration and uses excess water. This enhances movement of salts deeper into the soil profile.
- Once established on saline soils, perennial vegetation should be maintained as permanent cover. In this study, saline conditions improved where perennial grasses established.

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

Common Name	Species	Cultivar	Seeding Rate ^{1/} (PLS lbs/acre)
green wheatgrass	<i>Elymus hoffmannii</i> Jensen & Asay	'AC Saltlander'	15.00
tall wheatgrass	<i>Thinopyrum ponticum</i> (Podp.)A. - W.Liu & R. -C. Wang	'Alkar'	20.25
meadow bromegrass	<i>Bromus biebersteinii</i> Roem & Shult.	'Fleet'	24.75
forage mix ^{2/}	MIX	MIX	30.00
creeping foxtail	<i>Alopecurus arundinaceus</i> Poir.	'Garrison'	5.25
smooth bromegrass	<i>Bromus inermis</i> Leyss.	'Lincoln'	12.00
Canada wildrye	<i>Elymus canadensis</i> L.	'Mandan'	11.25
hybrid wheatgrass	<i>Elymus hoffmannii</i> Jensen & Asay	'NewHy'	21.00
slender wheatgrass	<i>Elymus trachycaulus</i> (Link) Gould ex Shinners	'Revenue'	8.25
western wheatgrass	<i>Pascopyrum smithii</i> (Rydb.) A. Love	'Rodan'	15.00
manystem wildrye	<i>Leymus multicaulis</i> (Kar. & Kir.) Tzvelev	'Shoshone'	12.75

^{1/} Seeding rates are based on NRCS North Dakota Field Office Technical Guide planting rates. Grasses were seeded at 1.5 times the standard full seeding rate for MLRA 55B.

^{2/} Forage mix consists of 50% 'AC Saltlander,' 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Table 2. Temperature and precipitation data for Carrington and Buchanan, North Dakota.

Year	Buchanan ^{1/}			Carrington ^{2/}		
	Avg Annual Temp	Apr-Jun Avg Temp	Total Annual Precip	Avg Annual Temp	Apr-Jun Avg Temp	Total Annual Precip
	-----F ⁰ -----		--inches--	-----F ⁰ -----		--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

^{1/}data from Jamestown Airport weather station. ^{2/}data from Carrington 4N NDawn weather station.

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

Cultivar	Buchanan			Carrington		
	CP ^{1/}	TDN ^{2/}	RFV ^{3/}	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
Forage Mix ^{4/}	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

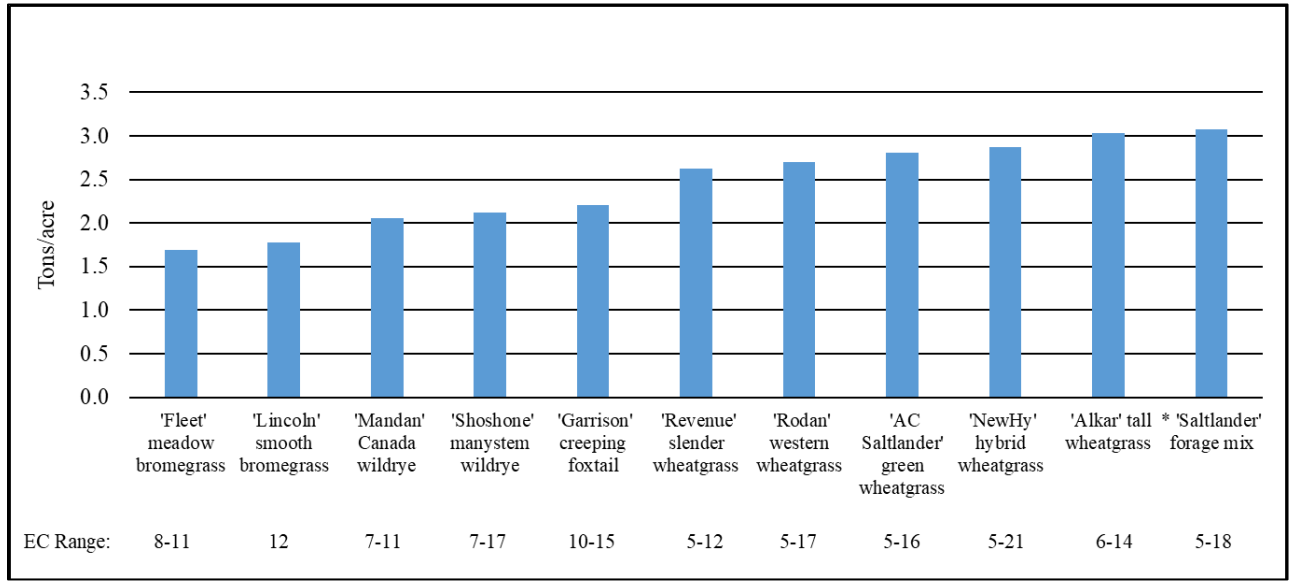
^{1/}crude protein, ^{2/}total digestible nutrients; ^{3/}relative feed value; ^{4/}forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney'tall fescue

Table 4. Summary of saline tolerance, forage quality, and biomass production of cool-season grasses evaluated on a known salinity gradient in Carrington and Buchanan, North Dakota.

Cultivar/Common Name	Salinity Tolerance	Highest Salinity Range	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 ^{1/}	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

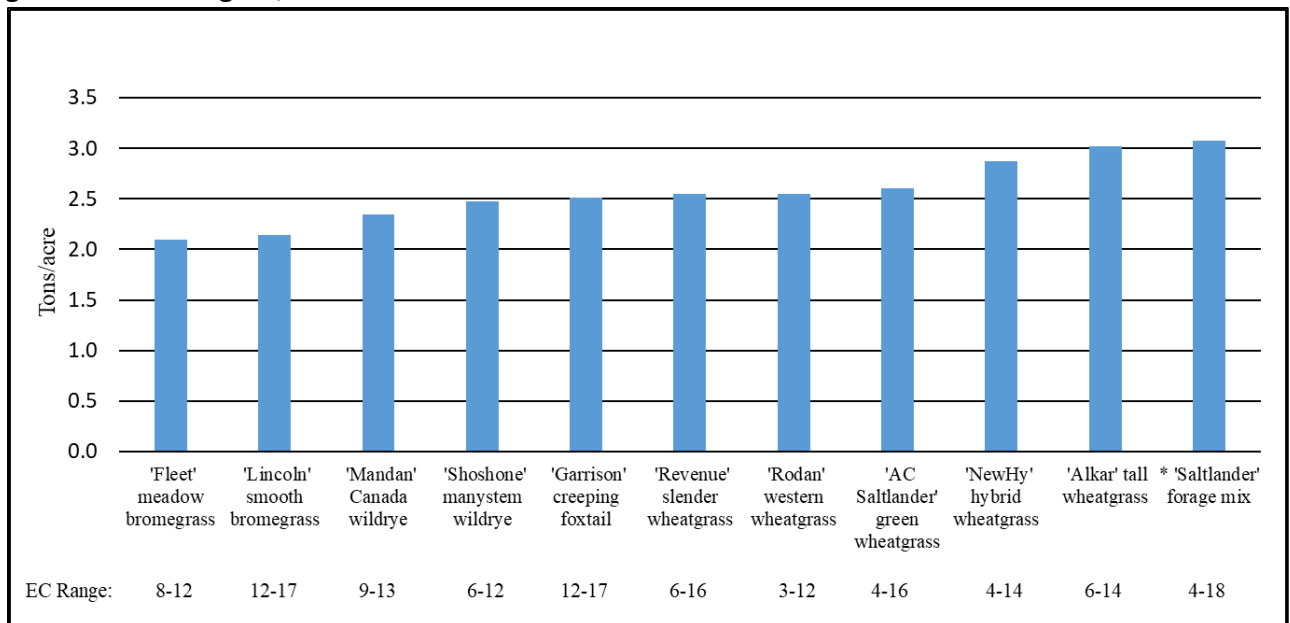
^{1/}'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue

Figure 1. Average 5-year forage production and EC (dS/m) ranges of cool-season grasses at Buchanan, North Dakota.



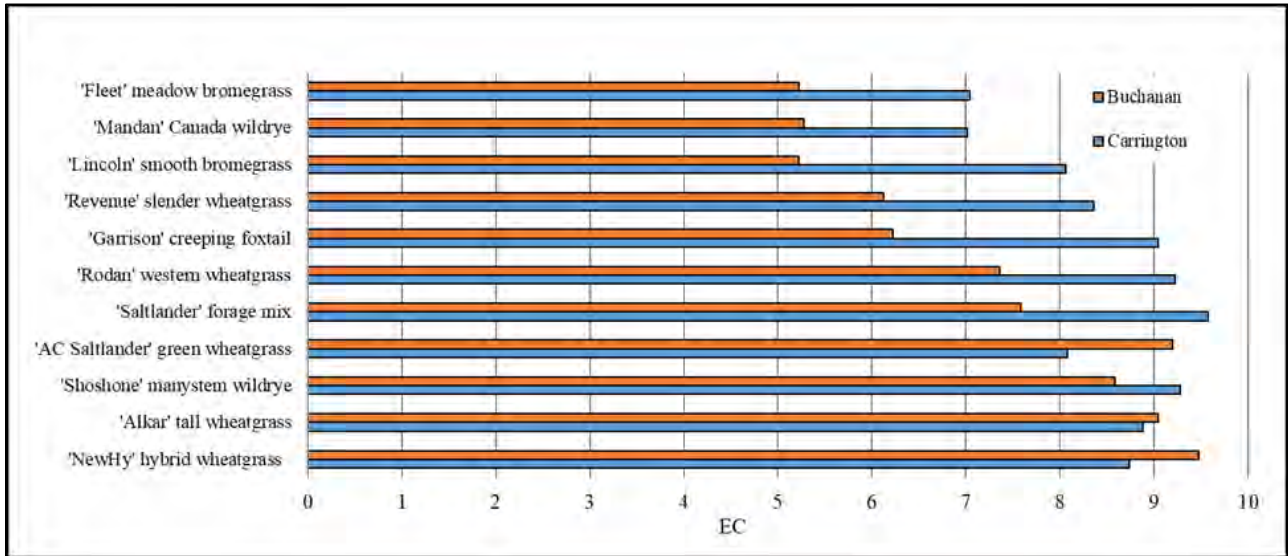
*'Saltlander' forage mix consists of 50% 'AC Saltlander', 25% 'Revenue' slender wheatgrass, 25% 'Courtney' tall fescue.

Figure 2. Average 5-year forage production and EC (dS/m) ranges of cool-season grasses at Carrington, North Dakota.



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

Figure 3. Salinity tolerance based on the average of the five highest EC (dS/m) levels for each cool-season grass species at Carrington and Buchanan, North Dakota.



Typical vegetation pattern with established grass (foreground) transitioning to kochia, foxtail barley, and bare soil as salinity levels increase.

For additional information about this field trial, contact the [Bismarck Plant Materials Center](#) or the [Carrington Research Extension Center](#). Information on specific species of plants mentioned in this publication is also available on the [USDA PLANTS](#) database, and information on soils and soil health is available on the [USDA NRCS Soils](#) website.