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DECIDUOUS SHELTERBELT LAND SUITABILITY FOR MAXIMIZED ECOSYSTEM CARBON STOCKS

No. SASK-41

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Deciduous shelterbelts are a vital component of Canadian farms; however, guidelines are lacking to help land managers locate suitable areas for planting new shelterbelts on their landbases. Therefore, to address this knowledge gap, we created a land suitability map for deciduous shelterbelt establishment across a wide range of climatic regions and soil zones of Saskatchewan. The land suitability map delineates and ranks the land across large landscapes in regards to maximized ecosystem carbon stocks in deciduous shelterbelts. The resulting suitability map is one of several important components built into the Shelterbelt Management Support Toolbox.

MAPPING DECIDUOUS SHELTERBELT LAND SUITABILITY IN SASKATCHEWAN

Maps of deciduous shelterbelt carbon data and 50 predictor variables were analyzed using multivariate principal component analysis (PCA), principal component regression (PCR), fuzzy logic analysis, and GIS mapping techniques. Statistically significant positive correlation between mapped deciduous shelterbelt suitability levels and observed mean shelterbelt carbon stocks were used to evaluate the resulting suitability map (4.86 million hectares (Mha) study area; $p<0.001$, $R2= 0.79$). The map delineated land of higher suitability for deciduous shelterbelts in the southern agricultural regions of Saskatchewan (Fig.1).

There are approximately 4.86 Mha of agricultural land on which shelterbelts of various lengths and designs were established using deciduous species. In general, across all soil zones and suitability map levels, the agricultural land with planted shelterbelts represented only 21% of the total agricultural landbase in the Province. In terms of availability of above-average or high level of suitability land for deciduous shelterbelt establishment, additional 8.76 Mha were mapped across the five soil zones, 78% of which are with above-average suitability and 22% are with high suitability (Fig. 1). The majority of these high and above-average suitability regions are located in the Brown (58%) and Dark Brown (41%) soil zones; the land availability in the other soil zones was <1%.

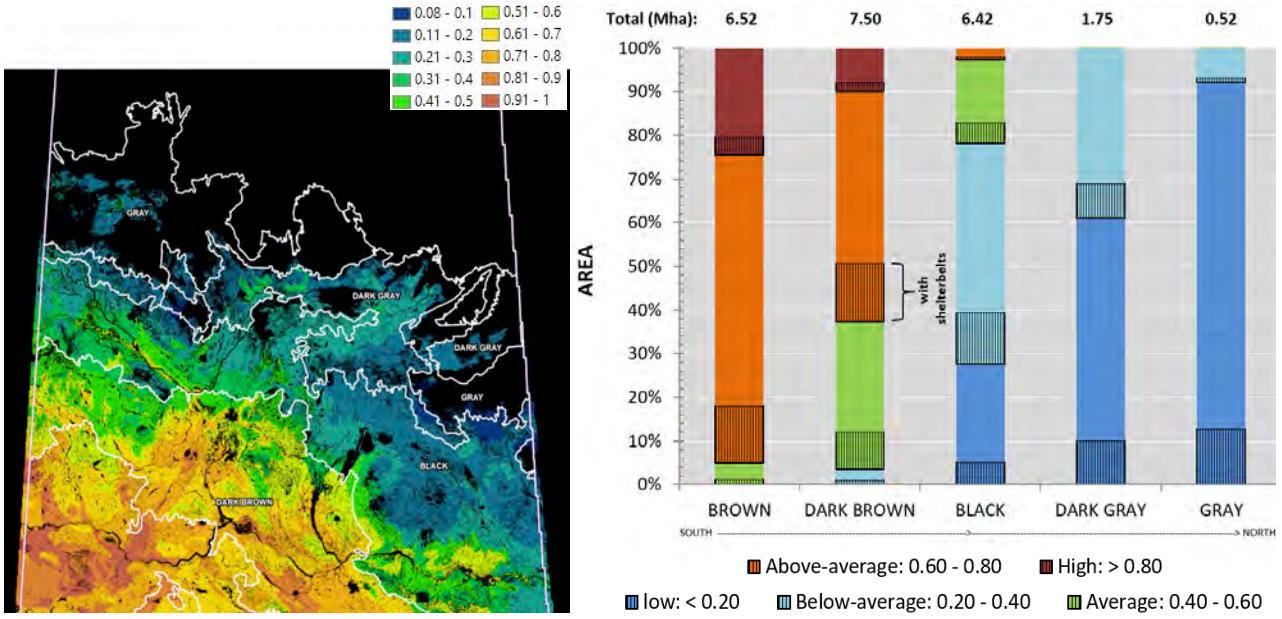

Figure 1. Deciduous shelterbelt suitability map (e.g., ash, maple, poplar).for Saskatchewan. Summaries of land areas (million ha (Mha) and % units) with and without shelterbelts are estimated for five land suitability classes (low, below-average, average, above-average, high) within five soil zones and shown in the bar graph.

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FACTORS AFFECTING DECIDUOUS SHELTERBELT C STOCKS

- **Factor interactions**: Deciduous shelterbelt C stocks and distribution are largely affected by (two-way) climate (temperature) and anthropogenic criteria interactions, as well as (three-way) climate (precipitation) and anthropogenic and soils criteria interactions.
- **High ranks**: The top three highest-ranking variables were annual growing degree-days, mean annual temperature, and semi-annual growing degree-days (January-July), all describing the temperature regime of an area.
- Deciduous shelterbelts were positively correlated with the top three ranking variables, meaning that shelterbelts are mainly distributed in agricultural areas with higher temperatures and higher annual growing degree-days.
- **Recommendations**: Future shelterbelts in the **Brown** soil zone should be planted using deciduous or shrub species.
- Most future shelterbelts in the **Dark Brown** soil zone should be planted using deciduous or shrub species, while the use of coniferous species be relatively more limited.
- Most future shelterbelts in the Black soil zone should be coniferous, with relatively limited use of deciduous or shrub species.
- Most future shelterbelts in the Dark Gray and Gray soil zones should be planted using coniferous species only.

Criteria Group	50 Variables	Units	Range (min; max)	Loading/Rank +/- load.	D
Clim	Growing Degree-Days annual	°C-day	(2191.7; 2965.9)	(+) 6.47	**1**
Clim	Mean annual Temp	°C	(0.4; 4.9)	(+) 6.43	**2**
Clim	GDD JanJul	°C-day	(1162.3; 1592.4)	(+) 6.26	**3**
Clim	Max annual Temp	°C	(6.2; 11.7)	(+) 6.19	**4**
Clim	Min annual Temp	°C	(-5.7; -1.8)	(+) 6.17	**5**
Clim	Max July Temp	°C	(20.7; 25.7)	(+) 5.79	**6**
Clim	Lowest Min Temp	°C	(-44.4; -35.6)	(+) 5.04	**7**
Clim	Vapour pressure deficit	kPa	(0.2; 0.4)	(+) 4.93	**8**
Mgmt	Hybrid poplar suitab. index	-	(0.3; 0.6)	(-) 4.92	**9**
Clim	Aridity Index	-	(0.5; 1)	(-) 4.55	**10**
Clim	Frost days	day	(192.6; 212.7)	(-) 4.42	**11**
Clim	Mean July Temp	°C	(15.3; 19.5)	(+) 4.24	**12**
Clim	Mean annual precipitation	mm	(218.2; 399.3)	(-) 3.98	**13**
Mgmt	Hardiness zone	-	(2; 7)	(+) 3.69	**14**
Clim	Solar radiation in July	MJ/m²	(513.7; 644.2)	(+) 3.58	**15**
Mgmt	Env. Indic. GHG farm emiss.	kg CO2-eq./ha	(-328.3; 582.5)	(-) 3.52	**16**
Clim	Wind speed	km/h	(11.9; 18.3)	(+) 3.05	17
Clim	Rain days	day	(36.3; 64)	(-) 2.6	18
Mgmt	Tillage farms-in-CCS	%	(0.7; 36.4)	(-) 1.74	19
Clim	Solar radiation	MJ/m²	(4376.7; 4986.8)	(+) 1.43	20
Soils	Agric. land erosion class	-	(1; 5)	(-) 1.3	21
Soils	Buk density (0-5 cm depth)	Mg/m3	(0.9; 1.4)	(+) 1.26	22
Mgmt	Tillage in-farm	%	(0; 27.6)	(-) 1.18	23
Topo	Elevation	m	(339.3; 1015.4)	(+) 1.15	24
Soils	Soil organic C (0-25 cm)	Mg/ha	(34.1; 98)	(-) 1.08	25
Clim	Rain for July	mm	(98.6; 180.1)	(-) 0.84	26
Mgmt	Irrigation farms-in-CCS	%	(0; 46.3)	(+) 0.5	27
Soils	Coarse fragments (0-5 cm)	vol. %	(0; 7.7)	(-) 0.49	28
Mgmt	Irrigation in-farm	%	(0; 18)	(+) 0.48	29
Soils	Agric. land drainage class	-	(3; 5)	(-) 0.45	30
Clim	Min July Temp	°C	(9.9; 13.6)	(+) 0.42	31
Soils	Elec. conductivity (0-5 cm)	mS/m	(0; 1.7)	(-) 0.36	32
Clim	Wind speed in Feb	km/h	(10.1; 17.5)	(-) 0.32	33
Clim	Growing season days	day	(122.1; 153.4)	(+) 0.25	34
Soils	pH (0-5 cm)	-	(5.5; 7.4)	(-) 0.15	35
Mgmt	Fertilizer farms-in-CCS	%	(1.4; 91.1)	(+) 0.14	36
Mgmt	Herbicides farms-in-CCS	%	(1.4; 93.5)	(+) 0.14	37
Soils	Agric. land capability class	-	(1; 6)	(+) 0.12	38
Clim	Wind speed in July	km/h	(10.4; 17.2)	(+) 0.09	39
Soils	Soil depth (plant-exploit.)	cm	(99.8; 200)	(-) 0.08	40
Mgmt	Herbicides in-farm	%	(1.1; 90)	(+) 0.06	41
Soils	Agricultural land texture cl.	-	(1; 4)	(-) 0.04	42
Mgmt	Fertilizer in-farm	%	(1.1; 88.9)	(+) 0.03	43
Mgmt	Crop type class	-	(34; 220)	(-) 0.02	44
Topo	Distance to water	m	(103; 980.9)	(-) 0.01	45
Soils	Clay (0-5 cm depth)	mass %	(9.4; 61.2)	(+) 0	46
Mgmt	Env. Indic. wind erosion	Mg/ha/yr	(0.2; 3.6)	(-) 0	47
Soils	AWHC (0-30 cm)	mm	(13.2; 35)	(+) 0	48
Soils	Sand (0-5 cm depth)	mass %	(7.9; 72.1)	(-) 0	49
Soils	Silt (0-5 cm depth)	mass %	(16; 45.9)	(-) 0	50

➔ **Table 1.** Ranking of 50 variables from four criteria groups (Clim = climate; Mgmt = land management; Soils = soil characteristics; Topo = topography) affecting agricultural land suitability for maximized shelterbelt ecosystem C stocks in Saskatchewan for deciduous shelterbelt species, such as ash, maple, poplar (D=deciduous). Ranks (1=highest; 50=lowest), top-third shown in bold and bottom-third as underlined values, are based on principal component analysis (i.e., variable loadings) and principal component regression (see fact sheet SASK-40). ➔

Environmental (climate and soils) and anthropogenic (i.e., farm management activities) factors affecting shelterbelt carbon stocks are in constant interactions, and therefore, should be considered collectively in all shelterbelt planning and management activities. We highly recommend using the deciduous shelterbelt suitability map accessible through the Saskatchewan Shelterbelt Carbon Tool.

FURTHER READING: Fact sheets SASK-40, SASK-42, SASK-43

CONTACT FOR MORE INFORMATION: SASKAGROFORESTRY.CA/

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