



AGGP-Agroforestry

# SHRUB SHELTERBELT LAND SUITABILITY FOR MAXIMIZED ECOSYSTEM CARBON STOCKS

## No. SASK-43

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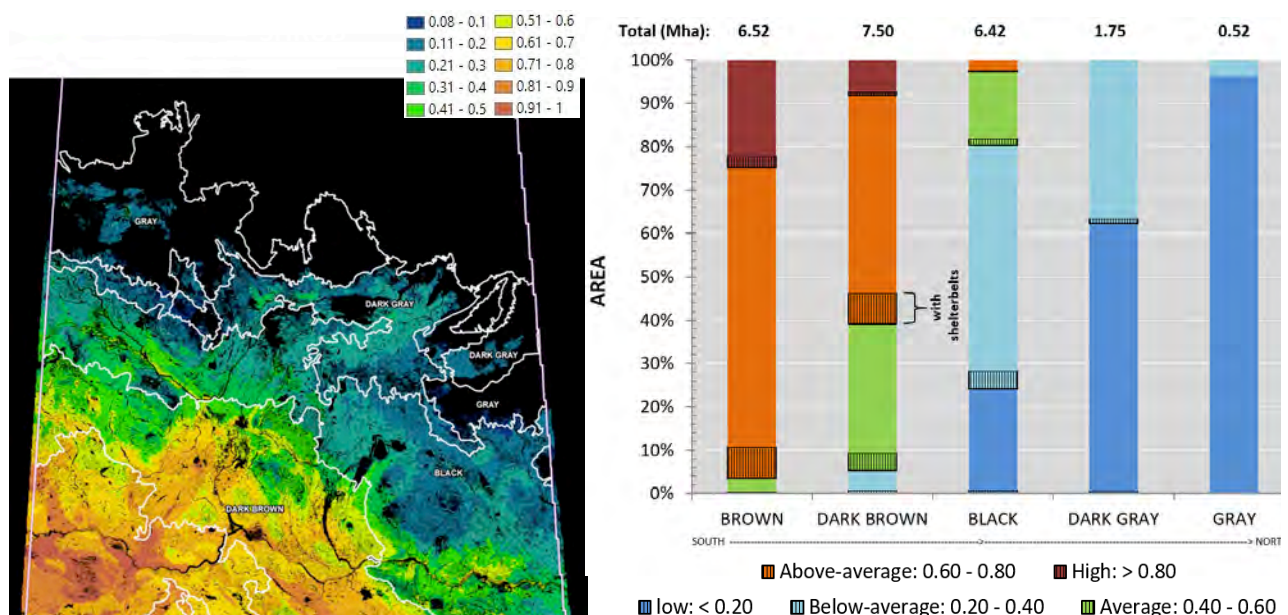
Shrub shelterbelts are fundamental for the protection of Canadian farms; however, guidelines are lacking to help land managers locate suitable areas for planting new shelterbelts on their landbases. Therefore, to address this knowledge gap, we created a land suitability map for shrub shelterbelt establishment (e.g. Caragana) 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 shrub shelterbelts. The resulting suitability map is one of several important components built into the [Shelterbelt Management Support Toolbox](#).

### MAPPING SHRUB SHELTERBELT LAND SUITABILITY IN SASKATCHEWAN

Maps of shrub 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 shrub shelterbelt suitability levels and observed mean shelterbelt carbon stocks were used to evaluate the resulting suitability map (2.07 million hectares (Mha) study area;  $p < 0.001$ ,  $R^2 = 0.83$ ). The map delineated land of higher suitability for shrub shelterbelts in the southern agricultural regions of Saskatchewan, similar to the deciduous shelterbelts suitability map (Fig.1).

There were approximately 2.07 million hectares of agricultural land on which shelterbelts of various lengths and designs were established using shrub species. In general, across all soil zones and suitability map levels, the agricultural land with planted shelterbelts represented only 9% of the total agricultural land base in the Province. In terms of availability of above-average or high suitability land for shrub shelterbelt planting, additional 9.77 Mha were mapped across five soil zones, 80% of which are above-average and 20% were high suitability. The majority of these additional land areas were located in the Brown (58%), and Dark Brown (41%) soil zones; land availability in the other soil zones was less than 1% (Fig. 1).

**Figure 1.** Shrub shelterbelt suitability map (e.g., Caragana) 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 SHRUB SHELTERBELT C STOCKS

- **Factor interactions:** Shrub shelterbelt C stocks and distribution are 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 mean annual temperature, maximum annual temperature, and annual growing degree-days, all describing the temperature regime of an area.
- Shrub shelterbelts were positively correlated with the top three ranking variables, meaning that shelterbelts are mainly distributed in agricultural areas with warmer 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.

→ **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 shrub shelterbelt species, such as Caragana (S= shrub). 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). →

Criteria Group	50 Variables	Units	Range (min; max)	Loading/Rank +/- load.	S
Clim	Mean annual Temp	°C	(0.4; 4.9)	(+) 6.39	<b>1</b>
Clim	Max annual Temp	°C	(6.2; 11.7)	(+) 6.19	<b>2</b>
Clim	Growing Degree-Days annual	°C day	(2191.7; 2965.9)	(+) 6.18	<b>3</b>
Clim	Min annual Temp	°C	(-5.7; -1.8)	(+) 6.08	<b>4</b>
Clim	GDD JanJul	°C day	(1162.3; 1592.4)	(+) 5.86	<b>5</b>
Clim	Max July Temp	°C	(20.7; 25.7)	(+) 5.63	<b>6</b>
Mgmt	Hybrid poplar suitab. index	-	(0.3; 0.6)	(-) 4.88	<b>7</b>
Clim	Lowest Min Temp	°C	(-44.4; -35.6)	(+) 4.81	<b>8</b>
Clim	Vapour pressure deficit	kPa	(0.2; 0.4)	(+) 4.77	<b>9</b>
Clim	Frost days	day	(192.6; 212.7)	(-) 4.7	<b>10</b>
Clim	Solar radiation in July	MJ/m <sup>2</sup>	(513.7; 644.2)	(+) 4.65	<b>11</b>
Clim	Aridity Index	-	(0.5; 1)	(-) 4.51	<b>12</b>
Clim	Mean July Temp	°C	(15.3; 19.5)	(+) 3.79	<b>13</b>
Clim	Mean annual precipitation	mm	(218.2; 399.3)	(-) 3.59	<b>14</b>
Mgmt	Hardiness zone	-	(2; 7)	(+) 3.52	<b>15</b>
Clim	Rain days	day	(36; 64)	(-) 3.37	<b>16</b>
Mgmt	Env. Indic. GHG farm emiss.	kg CO <sub>2</sub> -eq./ha	(-328.3; 582.5)	(-) 2.65	<b>17</b>
Soils	Agric. land erosion class	-	(1; 5)	(-) 1.95	<b>18</b>
Clim	Wind speed	km/h	(11.9; 18.3)	(+) 1.84	<b>19</b>
Clim	Solar radiation	MJ/m <sup>2</sup>	(437.7; 4986.8)	(+) 1.79	<b>20</b>
Topo	Elevation	m	(339.3; 1015.4)	(+) 1.66	<b>21</b>
Clim	Wind speed in Feb	km/h	(10.1; 17.5)	(-) 1.42	<b>22</b>
Topo	Distance to water	m	(103; 980.9)	(+) 1.36	<b>23</b>
Clim	Rain for July	mm	(98.6; 180.1)	(-) 1.18	<b>24</b>
Soils	Bulk density (0-5 cm depth)	Mg/m <sup>3</sup>	(0.9; 1.4)	(+) 1.06	<b>25</b>
Clim	Wind speed in July	km/h	(10.4; 17.2)	(-) 1.03	<b>26</b>
Soils	Soil organic C (0-25 cm)	Mg/ha	(34.1; 98)	(-) 0.76	<b>27</b>
Mgmt	Tillage farms-in-CCS	%	(0.7; 36.4)	(-) 0.74	<b>28</b>
Soils	Soil depth (plant-exploit.)	cm	(99.8; 200)	(+) 0.59	<b>29</b>
Soils	Coarse fragments (0-5 cm)	vol. %	(0; 7.7)	(-) 0.48	<b>30</b>
Mgmt	Fertilizer farms-in-CCS	%	(1.4; 91.1)	(+) 0.4	<b>31</b>
Mgmt	Herbicides farms-in-CCS	%	(1.4; 93.5)	(+) 0.35	<b>32</b>
Mgmt	Tillage in-farm	%	(0; 27.6)	(-) 0.33	<b>33</b>
Mgmt	Irrigation farms-in-CCS	%	(0; 46.3)	(+) 0.28	<b>34</b>
Clim	Growing season days	day	(122.1; 153.4)	(+) 0.22	<b>35</b>
Mgmt	Env. Indic. wind erosion	Mg/ha/yr	(0.2; 3.6)	(+) 0.22	<b>36</b>
Clim	Min July Temp	°C	(9.9; 13.6)	(+) 0.15	<b>37</b>
Mgmt	Crop type class	-	(34; 220)	(-) 0.14	<b>38</b>
Soils	Agric. land drainage class	-	(3; 5)	(-) 0.12	<b>39</b>
Soils	Agric. land capability class	-	(1; 6)	(+) 0.09	<b>40</b>
Soils	pH (0-5 cm)	-	(5.5; 7.4)	(+) 0.07	<b>41</b>
Mgmt	Herbicides in-farm	%	(1.1; 90)	(+) 0.07	<b>42</b>
Mgmt	Fertilizer in-farm	%	(1.1; 88.9)	(+) 0.04	<b>43</b>
Soils	Elec. conductivity (0-5 cm)	mS/m	(0; 1.7)	(-) 0.02	<b>44</b>
Soils	Agricultural land texture cl.	-	(1; 4)	(-) 0.02	<b>45</b>
Mgmt	Irrigation in-farm	%	(0; 18)	(-) 0.02	<b>46</b>
Soils	Clay (0-5 cm depth)	mass %	(9.4; 61.2)	(+) 0.02	<b>47</b>
Soils	Silt (0-5 cm depth)	mass %	(16; 45.9)	(-) 0.01	<b>48</b>
Soils	AWHC (0-30 cm)	mm	(13.2; 35)	(-) 0	<b>49</b>
Soils	Sand (0-5 cm depth)	mass %	(7.9; 72.1)	(-) 0	<b>50</b>

Shelterbelt suitability maps fill a knowledge gap of location guidance for shelterbelt planting, and can be built into decision support systems used by policymakers, researchers, or directly applicable to the decision-making process by the landowners themselves. We highly recommend using the shrub shelterbelt suitability map accessible through the [Saskatchewan Shelterbelt Carbon Tool](#).

**FURTHER READING:** Fact sheets SASK-40 through SASK-42

**CONTACT FOR MORE INFORMATION:** [SASKAGROFORESTRY.CA/](http://SASKAGROFORESTRY.CA/)

**ACKNOWLEDGEMENTS & COPYRIGHT:** This research was done by a team of collaborators from the Centre for Northern Agroforestry and Afforestation at the University of Saskatchewan, under the leadership of Dr. Colin Laroque. Funding was provided by Agriculture and Agri-Food Canada (AAFC)'s Agricultural Greenhouse Gases Program (AGGP). This fact sheet was completed in Feb 2020.

