Matching Winegrape Cultivars to Nebraska Landscapes

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Grapes were grown in Nebraska prior to the Prohibition—about 5000 acres.

Largely grown in the southeastern portion of the state.

The viticultural knowledge of the region was lost until the Farm Winery Act (1994).

~13 bonded wineries in Nebraska today and about 200 growers and 400 acres of vines.
A Geography of Viticulture

Concept of Terroir

- It embraces the soil landscape and subsoil, the geology (bedrock and landforms); microclimate down to the vine, the macroclimate of the region; elevation, slope, and aspect; proximity to other features—lakes, streams, windbreaks, or the structures of man; the viticulture (variety, rootstock, pruning, and training) and enology (fermentation style, length of maceration, and refinement); and the culture (ethnicity, traditions, and beliefs) of the site.

- The combined effect of a region’s geomorphic, pedologic, and climatic processes
- Defines the growing environment
- Reflects “uniqueness of place” or “sense of place”.
- Does Nebraska have terroirs? How would we recognize them?
Objectives

- Testing the grower observations and hypotheses that Tmin extreme values are pro-gressively becoming warmer in Nebraska through time, allowing a new window of opportunity for V. vinifera and French-American hybrids to be introduced and survive Nebraska winters,

- Matching winegrape cultivars to the landscapes and microclimates of the Northern Great Plains through terrain-modeling of thermal climate data, and

- Developing the biogeoinformatics characterizing the growing regions for winegrape cultivars that can eventually lead to the recognition of terroirs and development of American Viticultural Areas (AVAs).
Plant Hardiness Zones have shifted northward from the earlier version; Tmin extreme values are becoming warmer.

Urban heat island effects are becoming evident over the past 13 years in this study.

Winter hardiness ratings for cultivars developed in other regions may not readily translate to the Great Plains.
USDA Plant Hardiness Zone Map (2003)

1987 to 2001 Period of Record

4 -20 to -30 °F

5 -10 to -20 °F

6 0 to -10 °F

Cathey (2003); American Horticultural Society
Climate Parameters for Variety & Vineyard Site Selection

- **Growing Degree-Days (Base 50 °F); April 1 to October 31; No upper threshold (Winkler et al., 1974); Total heat units and cumulative days**
- **Average Tminimum Extreme--Isoline of -8 °F is an ecological boundary for Vitis vinifera; days/decade**
- **USDA Winter Hardiness Zones--4a to 6b**
- **Mean Frost-Free Period (Base 28 °F)--Need a 165 day window**
- **Mean January Air Temperature--Isoline of 30 °F is related to Pierce’s Disease**
- **Mean Annual Tmaximum <32 °F as Cumulative Days**
- **Mean Annual Number of Days of Tmaximum >90 °F**
- **Probability of 5-Consecutive Days >60 °F in January, February, or March**
- **Accumulation of GDDs (Base 32 °F) Consecutively for 1000 hrs (Bud Break)**

The parameters define the variety and sustainability of place, not necessarily the resulting quality and character of the wine.
Wine quality is a function of variety, soil, climate, landscape, and vineyard management.

- Mapping of Varietal Adaptation
- Vineyard Suitability and Sustainability
- El Nino/La Nina Impacts
- Vineyard Management Zones
- Terroirs and AVAs
## Climate Comparison of Major Vineyards in Nebraska

### 1971 to 2000 Normals

<table>
<thead>
<tr>
<th>Weather Station</th>
<th>FFP (28°F)</th>
<th>Days &lt;-10°F</th>
<th>Tmin Extreme</th>
<th>Abs Tmin</th>
<th>GDD (50°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuthills Vineyard Osmond</td>
<td>166</td>
<td>8.4</td>
<td>-21.0</td>
<td>-28</td>
<td>3249</td>
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<tr>
<td>Geo. Spencer Kearney 4 NE</td>
<td>177</td>
<td>3.8</td>
<td>-14.4</td>
<td>-30</td>
<td>3325</td>
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<tr>
<td>James Arthur Vineyard Lincoln AP</td>
<td>183</td>
<td>4.0</td>
<td>-15.2</td>
<td>-22</td>
<td>3605</td>
</tr>
<tr>
<td>Blue Valley Vineyard Crete</td>
<td>190</td>
<td>2.8</td>
<td>-14.5</td>
<td>-25</td>
<td>3714</td>
</tr>
<tr>
<td>Lovers Leap Vineyard Crawford</td>
<td>153</td>
<td>4.3</td>
<td>-17.5</td>
<td>-33</td>
<td>2742</td>
</tr>
<tr>
<td>Geneva Research Farm Geneva, NY</td>
<td>198</td>
<td>0.5</td>
<td>-7.2</td>
<td>-16</td>
<td>2485</td>
</tr>
</tbody>
</table>
Nebraska Research Initiative

Changes in Thermal Regime
Comparison of the Past 10 Years and the Total Length of Record

<table>
<thead>
<tr>
<th>Weather Station</th>
<th>Record</th>
<th>FFP (28°F)</th>
<th>Days &lt; -10°F</th>
<th>Tmin Extreme</th>
<th>Days &gt; 95°F</th>
<th>GDD (50°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebraska City</td>
<td>1994-2003</td>
<td>206</td>
<td>1.7</td>
<td>-10.6</td>
<td>5.1</td>
<td>3440</td>
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<tr>
<td>Nebraska City</td>
<td>1961-2003</td>
<td>202</td>
<td>3.0</td>
<td>-12.4</td>
<td>10.0</td>
<td>3477</td>
</tr>
<tr>
<td>Pawnee City</td>
<td>1994-2003</td>
<td>196</td>
<td>2.0</td>
<td>-13.3</td>
<td>14.6</td>
<td>3752</td>
</tr>
<tr>
<td>Pawnee City</td>
<td>1903-2003</td>
<td>191</td>
<td>2.5</td>
<td>-13.3</td>
<td>24.6</td>
<td>3934</td>
</tr>
<tr>
<td>Red Cloud</td>
<td>1994-2003</td>
<td>175</td>
<td>1.8</td>
<td>-9.6</td>
<td>27.8</td>
<td>3476</td>
</tr>
<tr>
<td>Red Cloud</td>
<td>1948-2003</td>
<td>174</td>
<td>3.5</td>
<td>-14.2</td>
<td>28.7</td>
<td>3549</td>
</tr>
<tr>
<td>Superior</td>
<td>1994-2003</td>
<td>195</td>
<td>0.5</td>
<td>-8.2</td>
<td>29.8</td>
<td>4008</td>
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<tr>
<td>Superior</td>
<td>1964-2003</td>
<td>193</td>
<td>1.7</td>
<td>-11.0</td>
<td>23.3</td>
<td>3842</td>
</tr>
</tbody>
</table>
Changes in Thermal Regime
U.S. Historical Climatology Network

Crete, NE

- Steeper slope to the trendline of winter minimum temperatures
- Allows over-wintering of grape pests and diseases
- Promoting earlier budbreak and frost damage in spring

Doane College
The Working Hypothesis

Major Land Resource Areas and Vineyards

MLRAs as an ecological framework for terroirs and AVAs
A Geography of Viticulture
Finding New Vineyard Sites with Extended Growing Seasons

A Finger Lakes Model for the Northern High Plains

Lake McConaughy

Vineyards in this region would have an extended growing season and total GDDs comparable to the Finger Lakes region, but the Tminimum extreme averages -12°F at Kingsley Dam. The surrounding weather stations average -17°F.

The lake buffering slows spring warm-up and premature budbreak, and reduces impact of late spring frosts.
## Nebraska Research Initiative

### Winterhardiness

<table>
<thead>
<tr>
<th>Minimum Extreme is Higher than...</th>
<th>Injury Hazard</th>
<th>Suitable Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F</td>
<td>Very Low</td>
<td>classic Vinifera</td>
</tr>
<tr>
<td>-5°F</td>
<td>Low</td>
<td>northern Vinifera</td>
</tr>
<tr>
<td>-10°F</td>
<td>Moderate</td>
<td>hardy Vinifera/most hardy</td>
</tr>
<tr>
<td>-15°F</td>
<td>High</td>
<td>hardy hybrids/most</td>
</tr>
<tr>
<td>&lt;-20°F</td>
<td>Very High</td>
<td>very hardy American cultivars/hybrids (Swenson cultivars)</td>
</tr>
</tbody>
</table>
**Nebraska Research Initiative**

**Length of Growing Season**

<table>
<thead>
<tr>
<th>Frost-Free Period (Consecutive Days between 28°F)</th>
<th>Suitability for Grapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 180 days</td>
<td>Excellent (most late season)</td>
</tr>
<tr>
<td>171 to 180</td>
<td>Good (mid- to late-season)</td>
</tr>
<tr>
<td>161 to 170</td>
<td>Satisfactory (mid- and early)</td>
</tr>
<tr>
<td>151 to 160</td>
<td>Marginal (only early)</td>
</tr>
<tr>
<td>&lt; 150 days</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>
Winterhardiness is the key to varietal selection the Northern Great Plains

At the Panhandle Research and Extension Center (1971-2000)

<table>
<thead>
<tr>
<th>FFP (28°F)</th>
<th>Days</th>
<th>Tmin</th>
<th>Abs</th>
<th>GDDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>163 d</td>
<td>5.0 d</td>
<td>-19.7°F</td>
<td>-42°F</td>
<td>2819</td>
</tr>
</tbody>
</table>
These four Nebraska locations occur within the proposed Vinifera Triangle and compared with the Geneva Experiment Station (NY). In the Vinifera Triangle, the spring warm-up is nearly 3-weeks faster than in the Finger Lakes region.
These four Nebraska cultivar trials are compared with the Geneva Experiment Station (NY).
Winegrape Adaptation Zones

The raw terrain surface of Tminimum extreme temperatures based upon 1971 to 2000 normals.

Frontenac, St. Croix, Lacrosse, Prairie Star, and Valiant

Nebraska Loess Uplands and Till Plains
Vinifera Triangle in Nebraska

- Cabernet Franc, Chardonnay, Lemberger, Riesling, Chambourcin, Chancellor, Seyval Blanc, Traminette, Norton/Cynthiana, and Chardonel

- Nebraska and Kansas Loess-Drift Hills
- Iowa and Missouri Deep Loess Hills
Summary and Conclusions

Maps of “genotype x environment”

- Trends toward warming of Tminimum extremes in the past 10 years in southeast and southcentral Nebraska
- Lengthening of frost-free period in the Republican River Valley
- Although a warming trend allows introduction of more vinifera and French/ American hybrids that will survive, pre-mature budbreak limits consistent harvests