UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Vineyard Site Selection in Kentucky
Based on Climate and Soil Properties

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Commercial wine grapes have recently emerged as an alternative crop in Kentucky after laws evolved encouraging private entrepreneurs to invest in vineyards and small farm wineries many decades after prohibition shut down the industry. Grapes grown in Kentucky are exposed to biotic and abiotic stresses that reduce crop yields and quality or kill grapevines. Damaging winter temperatures, spring frosts, and higher than optimal growing temperatures occur regularly. Despite these challenges, grape growing is a successful enterprise in many areas of the state.

Climate is the major limiting factor for sustainable grape growing in Kentucky due to the severity of winters. Vineyard site selection greatly affects crop yields, quality, and sustainability. This bulletin is intended to provide a rating index to evaluate vineyard site suitability for use by Extension personnel and potential grape growers.

Macroclimate

Macroclimate refers to the prevailing climate of a large geographic region. In Kentucky, air temperatures fluctuate on a day-to-day basis because the land does not buffer air temperatures; the macroclimate is classified as continental.

Overall, the quality of wine produced in any region comes primarily from the high quality of the grapes that are carefully vinified through long-held practices in the winery. The quality of the grape is the result of the combination of climate, site, geology, cultivar, and how these factors are managed together to produce the best crop. The macroclimatic properties of the viticultural regions in Kentucky are presented in Table 1 and Figure 1. Kentucky has five distinct growing regions ranging from Region I (prime) to Region V (undesirable). Region I lends itself to the production of premier grapes; Region V makes grape growing a challenge. For a detailed description of grape growing regions in Kentucky, see Extension publication *Viticultural Regions and Suggested Cultivars in Kentucky* (HO-88).

Table 1. Macroclimatic regions for viticulture in Kentucky based on climate data, 1974-2005.

Feature	Region I	Region II	Region III	Region IV	Region V
Occurrence of -15°F: percent of time	Hardly at all	Rarely	Frequently	Very frequently	Extremely frequently
Winter severity index: January mean temperature	Mildly cold (23°F to 32°F)	Cold (14°F to 23°F)	Very cold (5°F to 14°F)	Extremely cold (<5°F)	Extremely cold (<5°F)
Spring frost index (SPI): difference between average mean and average minimum for April	Very low risk	Low risk	Moderate risk	Moderate risk	High risk
Growing degree days: 50°F base temperature from 1 April through 30 October	3000-4000	3000-4000	3500-4000	3500-4000	>4000
Frost free days: between last spring frost occurrence at 32°F and first fall frost occurrence at 32°F	>181	>181	171-180	160-170	160-170
Growing season mean temperature: mean of daily maximum temperatures between 1 April and 30 October	Coolest	Cool	Intermediate	Warm	Hot

Figure 1. Viticultural regions of Kentucky.

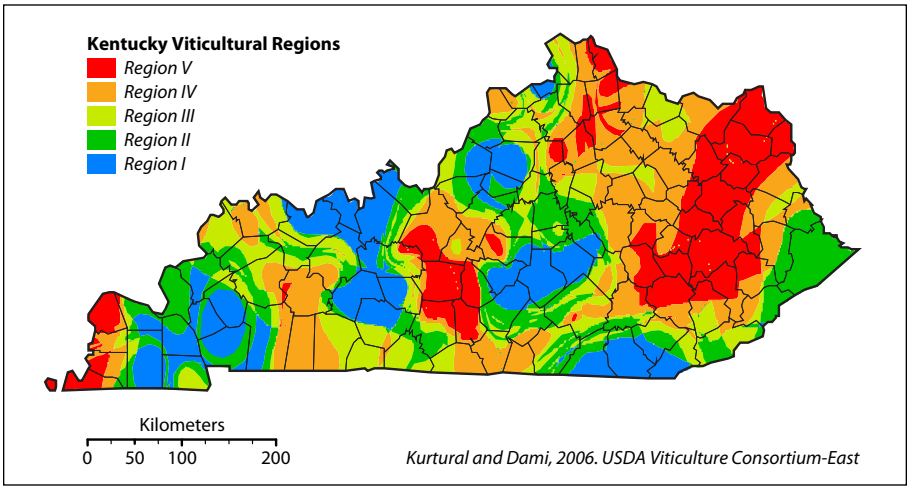
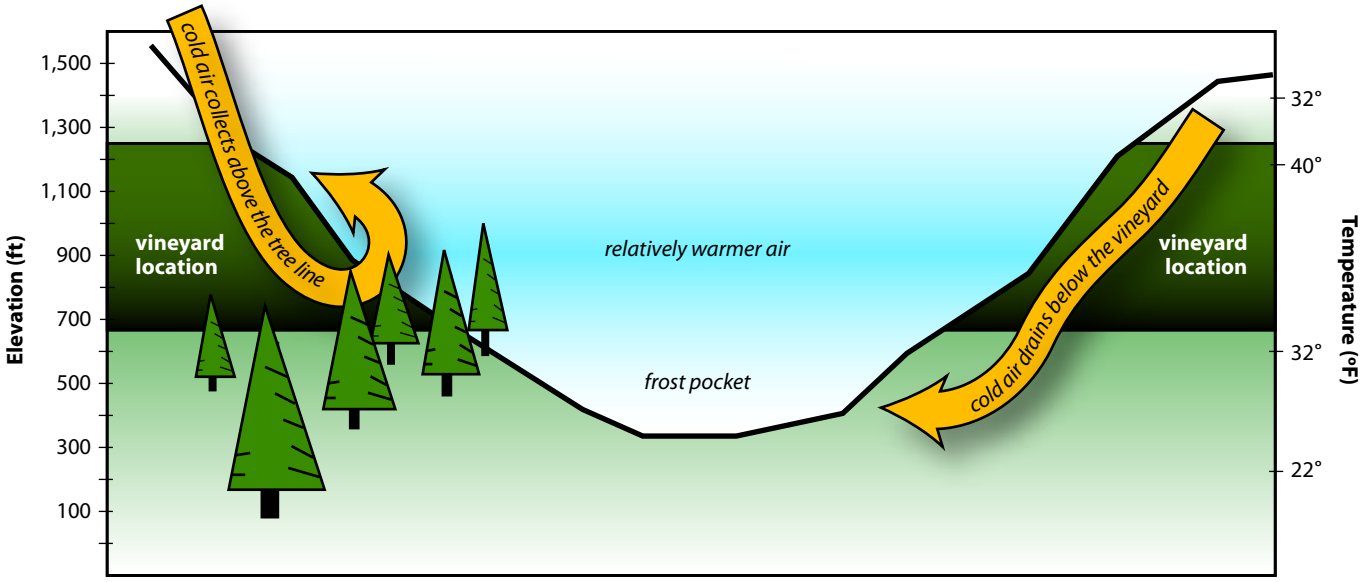


Figure 2. Effects of site topography on mesoclimate.



Mesoclimate

Mesoclimate, also referred to as topoclimate, is more specific than macroclimate. Mesoclimate is specific to a given site. Horizontal distances as little as 500 feet apart but on opposing hillsides may exhibit different mesoclimates due to absolute elevation, slope, and the compass direction.

Macroclimate maps are helpful in determining the regional suitability of vineyard sites, but these maps are usually too general to help locate the best vineyard sites on a given farm. The topography of a given site, including the absolute elevation, slope, aspect, and soils, greatly affects the suitability of the site.

Elevation

Absolute elevation affects air temperature, which makes it an important element in choosing a vineyard location. If a vineyard is on a slope, during radiative cooling conditions the cold, relatively dense air moves downhill and displaces warmer air to higher elevations. The sinking, cold air collects in low-lying areas and creates frost pockets. The effects of absolute elevation on air temperature during the month of April are summarized in Figure 2.

The relative elevation of a site is also important and must be considered in tandem with absolute elevation. Relative elevation refers to the relative position of a site to surrounding sites. Poor relative elevation can reduce the quality of an otherwise good elevation site. Small valleys that are perched in mountainous areas, even though they may fall within the best absolute elevation range, may still lie in pockets of cold air drainage. These areas are thus subject to more frost and winter injury.

Slope

The slope is the percentage of elevation change over horizontal distances. Perfectly flat land would have a slope of 0 percent, and vertical cliffs would have a slope of 100 percent. A slight to moderate slope (5-10 percent) is desirable in vineyard sites because it accelerates the drainage of denser cold air from the vineyard. Lands sloping greater than 15 percent are not recommended because operating equipment is hazardous on steep slopes, and these lands erode readily.

Aspect

The aspect of a slope is the prevailing compass direction that the slope faces. Aspect affects the angle that the sunlight hits the vineyards and thus its total heat balance. Even in warm grape-growing regions vineyards should be exposed to direct sunlight for at least a portion of the day. Eastern exposures provide this optimal exposure. The early morning exposure hastens onset of photosynthesis and speeds the loss of dew from the foliage and fruit. Vineyards with southern and western aspects can warm earlier in the spring, and the vines may undergo bud break earlier than vineyards on northern-facing slopes. Southern aspects in the northern hemisphere can lead to early deacclimation of grapevines during mid-winter (January thaw). Aspect also has an effect on winter temperatures. The effects of aspect on grapevine phenology have been documented in Kentucky from 2005 to 2007, and results are presented in Table 2.

Current Land Use

Current land use is not a direct indicator of vineyard suitability, but it affects the feasibility and the cost of establishing a vineyard. If land is classified as urban area, body of water, or transportation network, it would be unsuitable for agriculture, thus viticulture. Forests and wooded areas, however, can be cleared for agricultural purposes. But, forests are often in forest vegetation because they are too steep, too rocky, or other otherwise unsuited for cultivation. The optimum land use classification for a prospective vineyard site is agricultural because of the ease of conversion to vineyards.

Table 2. Effects of aspect on vine phenology at vineyard sites in the Bluegrass region of Kentucky.

Variable	Aspect			
	North	**South**	**East**	**West**
Date of bud break	Later	Earlier	Later	Earlier
Daily vine temperature	Less	More	Less	More
Drying of dew in the morning	No effect	No effect	Faster	Slower
Heating of fruit during summer	Less	More	Less	More
Heating of vines during January thaw	Less	More	Less	More
Winter air temperature	Lower	Higher	No effect	No effect
Frost free days	Less	More	No effect	No effect

Soil Characteristics

Soil, which is comprised of many components, affects grapevine productivity. The principal, published source of detailed soils data is the US Department of Agriculture (USDA) Soil Conservation Service's soil survey. This information is available by county and can usually be found at local Cooperative Extension offices, through the USDA Natural Resources Conservation Service's (NRCS) offices, or on the Web at http://soils.usda.gov/. The soils data provide detailed soil maps to identify soil series, with descriptive information on each soil series and sub-classification found in the county. Detailed, vineyard site–specific information should be obtained by collecting soil samples on the prospective property and evaluating the soil profile for color, depth, texture, bulk density, and degree of existing plant rooting. It is recommended that the Cooperative Extension Service in your county be involved in this process. A detailed description of desired vineyard soil properties can be found in the HortFact articles 3101 and 3112. Purchase of a prospective site can be made contingent upon an acceptable soil report.

As a general guideline, suitable vineyards should have at least 30 inches of rooting zone depth, drain extremely to moderately well, have a moderate organic matter percentage, and possess the chemical properties listed in HortFact 3101. The determining factors of soil suitability for the purposes of this bulletin are outlined below.

Internal Water Drainage

The best vineyard soils are those that permit deep and spreading root growth and provide a steady, moderate supply of water. The internal water drainage of vineyard soils is the most important soil physical property, and the desirable value is 2 inches per hour. Property can be modified with tile drainage during site establishment, but this addition increases the cost of establishment.

Organic Matter Percentage

Organic matter contributes porosity, structure, nutrients, and moisture to vineyard soils. The organic matter provides a pool of slowly available nitrogen to support vine growth. Organic matter values greater than 3-5 percent are counter-productive because excessive nitrogen released by organic matter decomposition may lead to excessive vegetative growth. The desired range for vineyard soils is 2-3 percent organic matter.

Soil pH

Soil pH can be modified during site preparation with lime or sulfur applications. Soil pH values from 6.0 to 6.8 provide the optimum availability of nutrients in vineyard soils. A soil pH less than 5.0 increases the aluminum solubility within the root zone and precipitates essential micronutrients such as iron out of the soil solution. However, some grape cultivars such as Concord and Norton prefer low soil pH.

Site Ranking

To determine whether a prospective site is suitable for commercial grape growing, use Tables 3 and 4.

Interpretation of vineyard site ranking is done by summing the total points from the above mentioned sub-classes of climate, soil, and current land use properties in Table 3. Use Table 4 below to calculate accumulated total points for a site to rank the vineyard suitability; it provides the point accumulation interpretation for a given site based on climate, soil, and land use properties.

Conclusions

This bulletin is designed to help prospective growers evaluate possible vineyard sites and minimize their risk. The state of Kentucky has a varied climate, which offers a challenging environment for grape producers attempting to grow commercially acceptable fruit. There is no ideal vineyard site. Producers cannot compromise on certain features such as elevation, soil drainage (internal and surface), and length of growing season. They can, however, accept some less than ideal properties, such as the vineyard's aspect or some soil features such as soil pH, which is easy to ameliorate.

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HortFact 3101. http://www.uky.edu/Ag/Horticulture/KF_31_01.pdf.

Table 3. Vineyard site ranking.

Sub-classifications			Point Value	Your Site
Macroclimate *(40 points possible)*	**Growing Region**	Region I	40	
		Region II	35	
		Region III	25	
		Region IV	15	
		Region V	10	
Mesoclimate *(40 points possible)*	**Absolute Elevation** *(ft)*	1290 - 1600	10	
		850 - 1290	20	
		800 - 850	18	
		750 - 800	16	
		700 - 750	14	
		650 - 700	12	
		600 - 650	10	
		550 - 600	8	
		500 - 550	6	
		450 - 500	4	
		<450	2	
	Slope *(%)*	5 - 10	10	
		11 - 15	8	
		1 - 4	5	
		0 *(flat)*	1	
	Aspect	Northeast	10	
		North, East	9	
		Northwest, Southeast	7	
		Flat *(no aspect)*	4	
		West	3	
		South	2	
		Southwest	1	
Soil Properties *(10 points possible)*	**Internal Water Drainage**	Well-drained	7	
		Moderately well-drained	5	
		Somewhat poorly drained	2	
		Poorly/very poorly drained	0	
	Organic Matter *(%)*	>5	0	
		3 - 5	1	
		2 - 3	3	
		1 - 2	2	
		<1	1	
Current Land Use *(10 points possible)*		Cultivated/Grassland	10	
		Shrubs	8	
		Forests/wooded	4	
		Urban	0	
		Water	0	
		Transportation	0	
Total Points			**100**	

Table 4. Site ranking for suitability based on point accumulation of subclasses.

Scoring	Suitability
85-100	Highly suitable
75-85	Suitable
65-75	Fair
55-65	Risky
<55	Unsuitable

HortFact 3112. http://www.uky.edu/Ag/Horticulture/siteprep3112.pdf.

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