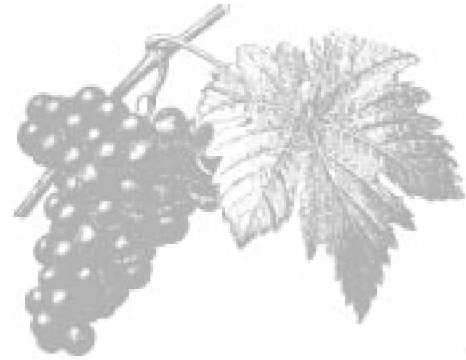
Chapter 1

Introduction



This production guide provides new and current grape growers with practical information on site appraisal, establishment, and operation of commercial vineyards in Virginia and North Carolina. The focus is on production of vinifera and hybrid wine grapes, although elements of the guide will be useful to table grape producers as well.

The cultivation of grapes in the eastern United States can be traced to attempts to grow "European" grapes (*Vitis vinifera*) at Jamestown colony in the 1600s. Those early viticultural efforts were hampered by indigenous pests, and colonial winemakers ultimately resorted to using the native grapes that flourished in the area.

Since the colonial period, grape and wine production in Virginia and North Carolina have undergone several notable periods of activity. In Virginia, Thomas Jefferson is often cited for his efforts to culture *V. vinifera* in the environs of Charlottesville. Jefferson, too, failed in this effort and recommended the culture of native American selections. Based on American species, a flourishing grape and wine industry materialized in Virginia and North Carolina, which became major wine-producing states near the end of the 19th century. The industry waned during and following Prohibition but gained momentum again during the 1970s and 1980s.

Much of the growth since the 1970s has been due to favorable legislation that recognized wine as an agricultural product. In Virginia, the Farm Winery Act was passed in 1980. Among other things, the Act provided certain tax breaks for development of farm wineries. For a winery to be classified as a *farm winery*, at least 51 percent of the grapes used in winemaking must be grown at the farm. An additional 25 percent of the grapes used may be purchased elsewhere within the state, and the remaining 24 percent may be obtained from other states.

Another catalyst to the growth of the Virginia wine industry was the creation in 1985 of the Virginia Winegrowers Advisory Board (VWAB). The board serves in an advisory role to the Virginia Department of Agriculture and Consumer Services and is funded by a state tax (currently $0.40 per liter) levied on Virginia wines. The board has successfully recommended the funding of numerous marketing, research, and educational programs that have been instrumental in promoting increases in grape production, wine quality, and wine sales.

Similar legislation in North Carolina has provided incentives for establishment of farm wineries in that state. The North Carolina Grape Council was created in 1986 and was given the responsibility of stimulating the growth of the state's wine and grape industry by sponsoring research, education, and promotion. Similar to the arrangement in Virginia, North Carolina legislation funded the North Carolina Grape Council by diverting the majority of the state's excise tax on North Carolina wines to the Council's use. Legislators in both states have continued to support their respective industries by passage of smaller legislative bills that have funded technical positions, reduced restrictions on where wines can be sold, and promoted winery tourism and sales through highway signage.

Today, grapes are grown throughout Virginia and North Carolina. Virginia has about 1,400 acres in grape production concentrated in the central piedmont and northern regions. This concentration is due as much to demographics as to viticultural suitability; it is interesting to note that few of the state's current growers purchased property specifically to grow grapes. North Carolina has about 550 acres of grapes, but this figure is declining as the acreage of Muscadine grapes is reduced. Bunch grapes, including *V. vinifera* and French-American hybrids, are grown throughout the piedmont and mountain regions of North Carolina.

Categories of Grapes

Four categories of grapes are grown in Virginia and North Carolina. The predominant category in Virginia is *V. vinifera*. Vinifera grapes are believed to have originated in Asia minor in the region of the Caspian and Black seas, and they are sometimes referred to as *Old World*, or European, grapes. They constitute over 80 percent of Virginia's grape acreage; Chardonnay, Riesling, and Cabernet Sauvignon are the most abundant varieties.

A second category of grape cultivated in Virginia and North Carolina consists of genetic hybrids of vinifera with native American species. Most of those hybrids were developed by European grape breeders in response to the destruction of much of Western Europe's own-rooted vinifera vineyards by the phylloxera root-louse in the late 1800s. A number of hybrids developed by French breeders were introduced into America in the 1940s and 1950s and became known as *French hybrids*. French hybrid varieties currently represent about 15 percent of Virginia's grape acreage, with Seyval and Vidal blanc leading in acreage. A third category comprises grapes of native American origin and interspecific hybrids of North American breeding programs. The parentage of many of those varieties is complex, and some were derived from crosses with vinifera vines. Included in the native American category are a number of table grapes, some of which are seedless. The native American grape varieties, dominated by Concord, constitute 5 percent of Virginia's grape acreage. Muscadine grapes (*Muscadinia rotundifolia*) represent the fourth group cultivated in this region. They represent a minor component of Virginia's grape cultivation but were significant in North Carolina until recently. Muscadines are susceptible to cold injury (temperatures of 10°F or lower) and are thus limited to sites having moderate winter temperatures, such as Virginia's tidewater region and much of North Carolina's coastal plain.

Besides cultivated grapes, the mid-Atlantic region hosts no fewer than five species of indigenous, wild grapes. Fruit from some of those species is edible but is decidedly inferior in yield and quality to the cultivated varieties.

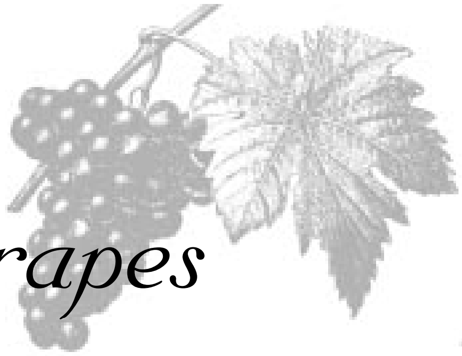
Because an understanding of grape production economics is a key to profitability, this guide starts by examining costs and returns for a commercial winegrape vineyard (chapter 2). The remaining chapters discuss grape varieties suitable for the mid-Atlantic region, site selection and vineyard establishment, pruning and training, canopy management, pest management, vine nutrition, water relations and irrigation, and crop prediction, all key aspects of successful vineyard management.

The information presented is based on both research and practical experience. Experienced growers and other grape experts often have differing opinions about production practices. This publication should therefore be considered as a guide to be used with other sources of information such as the publications listed at the ends of the chapters. Be sure to exercise caution, however, in applying concepts and practices recommended for viticultural regions that differ greatly in climate and soils from those in the mid-Atlantic region.

Although the guidelines in this publication are intended primarily for growers in Virginia and North Carolina, much of the information is applicable to grape production in the entire mid-Atlantic region — Maryland, Pennsylvania, New Jersey, Delaware, and West Virginia — as well.

Chapter 2

Costs of Growing Grapes



Establishing a successful commercial vineyard requires a substantial capital investment as well as sound management decisions from the initial planning stage through the sale or use of the harvested crop. To illustrate typical costs and returns from grape production, this chapter presents enterprise budgets for a typical 10-acre vineyard during its first eight years of operation. These budgets can serve as a model for potential investors to use in projecting income and expenses for a new vineyard planting. Existing vineyard owners and managers may find this information helpful in budgeting and in making comparisons with their own vineyard operations.

Vineyard establishment and operating costs can vary significantly within the mid-Atlantic region because of differences in the cost of real estate, labor, machinery, and materials. Costs are also affected by vineyard site, grape variety, vine spacing, training system, pest management strategies, and other cultural practices. Tables 2.1 through 2.8 present budgets for a typical 10-acre vineyard during its first eight years of operation. These budgets are based on the use of practices and materials that have proven both practical and cost-effective under a wide range of growing conditions. It may be possible to find alternative materials or practices that can reduce operating costs without impairing vineyard productivity or grape quality. The costs and returns per acre are based on a 10-acre planting of grafted vinifera grapevines, such as the variety Chardonnay. With adjustments for vine cost, crop value, and certain cultural practices, the budgets could also be applied to the production of interspecific hybrid (French hybrid) winegrapes and table grapes.

Note: This chapter was adapted from *The Cost of Growing Winegrapes in Virginia*, by D. H. Vaden and T. K. Wolf, publication 463-006, Virginia Cooperative Extension Service, 1994.

Labor

Labor represents more than 20 percent of the establishment cost and over 40 percent of the annual operating cost of a vineyard. The lack of trained labor may discourage many who would otherwise consider grape production. A 5-acre planting can be managed by one trained individual, who can do most of the work on weekends and evenings if necessary. Vineyards of 10 or more acres, on the other hand, typically require a full-time owner-operator plus additional full- or part-time labor at certain times. Harvesting poses the greatest labor demand because the fruit must be removed within a relatively short period. Labor costs are calculated at $7.50 per hour. Time required to complete a task varies with such factors as organizational skills, weather, and the amount and quality of labor. Times shown in the enterprise budgets are averages.

Land

One of the principal costs of establishing a vineyard is purchasing the land itself. Land prices in Virginia and North Carolina have escalated in recent years because many

Table 2.1. Enterprise Budget for Year 1 Operation of a 10-Acre Winegrape Vineyard

	Hours Per Acre	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Site Preparation					
Liming — 3 tons per acre		$16.00	3.00	$48	______
Plow and disk — labor	3.0	7.50		23	______
Sow cover crop — labor	1.0	7.50		8	______
Cover crop seed (tall fescue @ 50 lb/acre)		0.68	50.00	34	______
Vineyard Layout					
Mark vine and post locations	5.0	7.50		38	______
Auger vine holes (2 workers @ 3 minutes per hole)	60.5	7.50		454	______
Planting					
Vines		2.90	605.00	1,755	______
Planting (2 minutes per vine)	20.2	7.50		151	______
Trellising Materials					
3" x 8' CCA-treated line posts		3.25	187.00	608	______
6" x 8' CCA-treated end posts		6.00	22.00	132	______
12.5-ga. HT wire (4,000 feet per roll or unit)		60.00	8.47	508	______
End-post anchors (5/8" x 4' with helical end)		3.85	22.00	85	______
In-line ratchet wire strainers for cordon wires		1.75	11.00	19	______
Wirevise wire strainers for foliage catch wires		1.50	66.00	99	______
Staples (28 lb) and wire crimping sleeves (44)				31	______
Trellising Labor					
Distribute and drive line posts (2 workers @ 3 min/post)	18.7	7.50		140	______
Auger and set end posts	6.0	7.50		45	______
Mark and drill end posts for wirevises	3.0	7.50		23	______
Mark posts for wires	2.0	7.50		15	______
Install end-post anchors with PTO attachment	5.0	7.50		38	______
String wire, staple to posts, and tighten	15.0	7.50		113	______
Weed Control					
Glyphosate herbicide application before planting		44.04	0.17	7	______
Oryzalin herbicide application after planting		64.00	0.33	21	______
Herbicide application labor	2.0	7.50		15	______
Mowing row middles (6 mowings)	4.0	7.50		30	______
Fertilization					
Ammonium nitrate (0.25 lb per vine)		0.14	151.25	21	______
Hand application of ammonium nitrate	2.0	7.50		15	______
Canopy Management					
Bamboo stakes for trunk support		0.17	605.00	103	______
Shoot thinning and shoot tying to stakes (twice)	20.0	7.50		150	______
Tying materials (for securing trunks, canes, and shoots)				5	
Flower cluster removal	2.0	7.50		15	______
Fungicide and Insecticide Application					
Spray materials (see Table 2.12)				78	______
Spray labor (6 sprays @ 0.5 hr per spray)	3.0	7.50		23	______
Machinery					
Cash operating expenses only (see Table 2.9)				578	______
Operating Interest					
Interest charged on yearly cash expenses for 0.5 yr		8.00%	$5,428.00	217	______
Total Annual Cash Expense (Per Acre) — Year 1				$5,645	______

Table 2.2. Enterprise Budget for Year 2 Operation of a 10-Acre Winegrape Vineyard

	Hours Per Acre	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Dormant Pruning					
Pruning and tying of canes before budbreak	10.0	$7.50		$75	______
Weed Control					
Oryzalin application in spring		64.00	0.33	21	______
Spot treatment with postemergence herbicide		44.04	0.08	4	______
Total herbicide application labor	2.0	7.50		15	______
Mowing row middles (6 mowings)	4.0	7.50		30	______
Replanting					
Plants (2% of initial planting)		2.90	12	35	______
Replanting labor (5 minutes per vine)	1.0	7.50		8	______
Canopy Management					
Shoot thinning and shoot tying to stakes (twice)	30.0	7.50		225	______
Flower cluster removal	8.0	7.50		60	______
Tying materials (for securing trunks, canes, and shoots)				5	______
Fungicide and Insecticide Application					
Spray materials (see Table 2.12)				253	______
Spraying labor —10 sprays (0.5 hr per spray)	5.0	7.50		38	______
Machinery					
Cash operating expenses only (see Table 2.9)				217	______
Operating Interest					
Interest charged on yearly cash expense for 0.5 yr		8.00%	$ 986.00	39	______
Interest on Year 1 accrued cash expense		8.00%	$5,645.00	452	______
Total Annual Cash Expense (Per Acre) — Year 2				1,477	______
Total Accumulated Cash Expense				$7,122	______

Table 2.3. Enterprise Budget for Year 3 Operation of a 10-Acre Winegrape Vineyard

	Hours Per Acre	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Dormant Pruning					
Spur pruning and brush pulling	20.0	$7.50		$ 150	_____
Cordon training and tying	20.0	7.50		150	_____
Weed Control					
Oryzalin application in spring[a]		64.00	0.33	21	_____
Spot treatment with postemergence herbicide		44.04	0.08	4	_____
Total herbicide application labor	2.0	7.50		15	_____
Mowing row middles (6 mowings)	4.0	7.50		30	_____
Fertilization[b]					
Leaf petiole sampling for tissue analysis	0.3	7.50		2	_____
Processing of tissue sample				20	_____
Canopy Management					
Shoot thinning	10.0	7.50		75	_____
Shoot positioning (3 times)	30.0	7.50		225	_____
Selective leaf removal	25.0	7.50		188	_____
Tying materials (for securing trunks, canes, and shoots)				5	_____
Fungicide and Insecticide Application					
Spray materials (see Table 2.12)				220	_____
Labor — 12 sprays (0.5 hr per spray)	6.0	7.50		45	_____
Harvest Costs					
Picking — 2.0 tons[c]		1.25	160.00	200	_____
Harvest lugs[d]		5.50	80.00	440	_____
Machinery					
Cash operating expenses only (see Table 2.9)				254	_____
Operating Interest					
Interest charged on yearly cash expenses for 0.5 yr		8.00%	$2,044.00	82	_____
Interest on year 2 accrued cash expense at 8%		8.00%	$7,122.00	570	_____
Total Annual Cash Expense (Per Acre) — Year 3				2,696	_____
Total Accumulated Cash Expense				9,818	_____
Harvest Income					
Yield of 2 tons per acre		$1,150.00	2.00	(2,300)	_____
Net Investment at End of Year 3				$7,518	_____

[a] Either oryzalin or simazine may be used in year 3. Costs shown are for oryzalin application.

[b] The need for a particular nutrient is best determined through visual assessment of vines and by routine leaf petiole sampling for nutrient analysis. Fertilizer costs will therefore vary with the nutrient needs in individual vineyards. A single tissue sample may suffice for an entire 10-acre planting.

[c] Picking costs are calculated on the basis of $1.25 per 25-pound lug of fruit.

[d] Approximately 60 percent of the lugs necessary for harvesting are purchased during the third year. The balance are borrowed from the winery to which the grapes are to be sold.

Table 2.4. Enterprise Budget for Year 4 Operation of a 10-Acre Winegrape Vineyard

	Hours Per Acre	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Dormant Pruning					
Spur pruning and brush pulling	20.0	$7.50		$ 150	______
Cordon training and tying	5.0	7.50		38	______
Weed Control					
Preemergence herbicide		2.85	1.3	3	______
Spot treatment with postemergence herbicide		44.04	0.08	4	______
Total herbicide application labor	2.0	7.50		15	______
Mowing row middles (6 mowings)	4.0	7.50		30	______
Fertilization[a]					
Materials and rates will vary				35	______
Canopy Management					
Comparable to year 3				493	______
Fungicide and Insecticide Application					
Comparable to year 3				325	______
Harvest Costs					
Picking — 3.5 tons		1.25	280.00	350	______
Harvest lugs[b]		5.50	60.00	330	______
Machinery					
Cash operating expenses only (see Table 2.9)				279	______
Operating Interest					
Interest charged on yearly cash expenses for 0.5 yr		8.00%	$2,050.66	82	______
Interest on accrued investment minus year 3 crop sale at 8%		8.00%	$7,518.00	601	______
Annual Cash Expense (Per Acre) — Year 4				2,734	______
Total Accumulated Cash Expense				10,252	______
Harvest Income					
Yield of 3.5 tons per acre		1,150	3.50	(4,025)	______
Net Investment at End of Year 4				$6,227	______

[a] Materials and quantities will vary with individual vineyards. The most commonly applied materials are nitrogen, boron, magnesium, and lime. The costs shown are averages for materials, application, and alternate-year tissue sampling.

[b] Approximately 40 percent of the lugs necessary for harvesting are purchased during the fourth year.

Table 2.5. Enterprise Budget for Year 5 Operation of a 10-Acre Winegrape Vineyard

	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Operating Expense				
Similar to year 4, less lug costs			$1,721	______
Operating Interest				
Interest on year 5 net accrued cash expense	8.00%	$1,720.66	69	______
Interest on accrued investment minus year 4 crop sale	8.00%	6,227.00	498	______
Annual Cash Expense (Per Acre) — Year 5			2,288	______
Total Accumulated Cash Expense			8,515	______
Harvest Income				
Yield of 3.5 tons per acre	$1,150.00	3.50	(4,025)	______
Net Investment at End of Year 5			$4,490	______

Table 2.6. Enterprise Budget for Year 6 Operation of a 10-Acre Winegrape Vineyard

	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Operating Expense				
Same as year 5			$1,789	______
Operating Interest				
Interest on accrued investment minus year 5 crop sale	8.00%	$4,490.00	359	______
Annual Cash Expense (Per Acre) — Year 6			2,148	______
Total Accumulated Cash Expense			6,638	______
Harvest Income				
Yield of 3.5 tons per acre	$1,150.00	3.50	(4,025)	______
Net Investment at End of Year 6			$2,613	______

Table 2.7. Enterprise Budget for Year 7 Operation of a 10-Acre Winegrape Vineyard

	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Operating Expense				
Same as year 5			$1,789	______
Operating Interest				
Interest on accrued investment minus year 6 crop sale	8.00%	$2,613.00	209	______
Annual Cash Expense (Per Acre) — Year 7			1,998	______
Total Accumulated Cash Expense			4,611	______
Harvest Income				
Yield of 3.5 tons per acre	$1,150	3.50	(4,025)	______
Net Investment at End of Year 7			$586	______

Table 2.8. Enterprise Budget for Year 8 Operation of a 10-Acre Winegrape Vineyard

	Unit Cost	Units Per Acre	Cost Per Acre	Your Estimate
Operating Expense				
Same as year 5			$1,789	______
Operating Interest				
Interest on accrued investment minus year 7 crop sale	8.00%	$586.00	47	______
Annual Cash Expense (Per Acre) — Year 8			1,836	______
Total Accumulated Cash Expense			2,422	______
Harvest Income				
Yield of 3.5 tons per acre	$1,150.00	3.50	(4,025)	______
Net Return — Year 8			$1,603	______

potential vineyard sites and marketing locations have become desirable sites for real estate development. Because land costs vary so widely throughout the region, they are not reflected in these budgets. Furthermore, no costs are included for major land preparation activities such as clearing timber, removing rocks, leveling the land, or establishing a gravel road.

Water

Many vineyards can benefit from supplemental irrigation, especially during their first year. However, no capital expense for digging a well or pond is included in these budgets. Obtaining reliable and informed opinions from several experienced persons will help you in deciding whether irrigation is needed to protect the vineyard from drought and possibly from frost by means of an overhead irrigation system. Owners of some frost-prone vineyards in western North Carolina have invested over $6,000 per acre to install overhead irrigation systems in recent years.

Deer Exclusion

The white-tailed deer is one of the region's most popular game animals, but as deer numbers have increased in recent years it has become a serious vineyard pest. (See Chapter 8.) A deer damage control program that includes fencing should be planned and incorporated in the budget for a new vineyard. No costs are included for deer exclusion in the 10-acre vineyard enterprise presented in this chapter, but be sure to assess each potential vineyard site realistically for its vulnerability to deer damage.

Vineyard Machinery

A commercial vineyard of any size requires some basic equipment, including a tractor large enough for spraying, mowing, and other vineyard operations. Equipment used for spraying insecticides and fungicides on foliage is different from that used to spray for weed control. Vineyard sprayers are usually of the air-blast type and cost several thousand dollars or more, depending on the size of the vineyard. Air-blast sprayers are available as either tractor-mounted or trailer-mounted units. Smaller sprayers require a tractor that can deliver at least 35 horsepower at the drawbar. A new 35-horsepower tractor costs $15,000 or more. In addition, a tractor with four-wheel drive may be desirable for spraying in vineyards with difficult terrain. The purchase of a mechanical harvester may become a matter of necessity in large vineyards (for example, 50 to 100 acres) or for medium-size vineyards where an adequate number of harvest workers are simply unavailable. (Seven to 10 workers per acre are usually needed for harvest.) The basic machinery complement for a 10-acre vineyard is shown in Table 2.9, along with the respective operating expenses. No charges have been assigned in these budgets for various fixed ownership costs such as insurance, taxes, depreciation, or capital recovery (Table 2.11).

Assumptions

The budgets presented in Tables 2.1 through 2.8 are based on the following assumptions:

1. The vineyard is established at an excellent site where the hazards of winter cold injury and spring frosts are minimal. Thus, the costs for hilling and dehilling of graft unions and special frost protection equipment or compensation strategies are not included. Investment in frost protection equipment can total $20,000 to $30,000 for a 10-acre vineyard.

2. A deer fence around the perimeter of the vineyard is not used. Deer can be especially hard on young, developing vines, and deer feeding can easily cost one or two years of development time.

3. The vineyard is optimally managed and the vines are brought into production quickly. Crop yields of 3.5 tons per acre are expected in the third and subsequent years. (Although greater yields may be possible, most Chardonnay producers in Virginia currently obtain between 2 and 3 tons per acre (Table 2.10).

The budgets are presented in an operations format, in which each operation is listed in the general order in which it is performed. Costs are categorized as labor, materials, and machinery. Each enterprise budget is for one calendar year, and all budgets are prepared as of the end of their respective years. Operating capital interest is calculated on yearly cash expenses at 8 percent per year. The interest on annual operating costs is calculated at 8 percent for 6 months. This charge may be thought of as the interest cost

Table 2.9. Machinery Inventory and Cost of Operation Per Hour and Per Acre

Machine	Cost Per Hour	Cost Per Acre Year 1	Year 2	Year 3	Years 4-8
50-horsepower tractor	$4.05	$345.10	$ 56.70	$ 87.90	$108.10
Four-wheel-drive, 3/4-ton pickup truck (cost/mile)	0.29	145.00	145.00	145.00	145.00
50-gallon, 3-pt.-hitch herbicide sprayer	1.27	2.50	2.50	1.30	1.30
Post driver, 3-pt.-hitch mount	1.20	13.40			
200-gallon, trailer-hitch pesticide sprayer	2.82	8.50	11.30	16.10	16.10
6-foot mower and brush chopper	0.63	1.30	1.30	1.30	1.30
Fertilizer spreader/seed broadcaster	1.44	0.70			
PTO-driven 12-inch auger	1.12	52.60			
5-foot flatbed wagon or trailer	0.58	8.70		2.90	7.00
Total machinery cash expense		$577.80	$216.80	$254.40	$278.70

Table 2.10. Productivity Achieved by Virginia Chardonnay Producers in 1991 and 1992

Rank[a]	Yield (tons/acre) Mean	Range	Gross Return Per Acre[b]	Number of Growers	Acreage Represented
1991					
Lower 25%	0.5	(0.0 – 1.1)	$ 575	22	69
Middle 50%	2.3	(1.2 – 3.5)	2,645	45	193
Upper 25%	4.3	(3.5 – 7.0)	4,945	22	79
1992					
Lower 25%	0.6	(0.0 – 1.6)	690	23	65
Middle 50%	2.6	(1.7 – 3.5)	2,990	45	158
Upper 25%	4.7	(3.6 – 7.3)	5,405	23	120

Note: Productivity was based only on acreage that was three or more years old each year. The 1991 and 1992 seasons were good years from a yield standpoint.

[a] Virginia growers were grouped into three classes according to their productivity.

[b] Based on an average value of $1,150 per ton.

associated with borrowing money for the first year's cash expenses. This charge is included to reflect the fact that the capital you invest in producing winegrapes could be invested elsewhere and earn interest. The budgeted costs do not reflect any interest charge for intermediate or long-term capital provided by the owner. In developing your own budget, you may wish to consider a noncash charge against the grape enterprise for the use of owner capital if you have purchased land, made site improvements, built roads, or purchased frost control equipment or a mechanical harvester for the vineyard operation.

The budgets include no charge for management fees, but you may wish to consider making such a charge. In some farm enterprise budgets, management fees of 15 percent of cash expenses are included to reflect the value of the manager's time. Consulting is sometimes provided by outside experts in winegrape production and should be charged against the enterprise as a cash expense. Chardonnay grapes are priced at $1,150 per ton in the vineyard. Machinery cost factors and the vineyard spray program by year are given in Tables 2.11 and 2.12, respectively. The following paragraphs describe the expenses and returns for each year's budget.

Year 1

Site preparation includes a lime application of 3 tons per acre. The vineyard floor is planted to a grass cover crop before the vineyard is established. Following vineyard establishment, a 3-foot-wide weed-free strip is created and annually maintained under the trellis with a combination of preemergence and postemergence herbicides. Although it is assumed that weed control is performed using traditional chemical herbicides, other methods can be used.

The $1,755 spent for vines is a major cost item in the first year and represents approximately 30 percent of the total annual cash expense per acre for the winegrape enterprise in year 1 (Table 2.1). Vines are planted 8 feet apart in rows 9 feet wide. A total of 605 vines are planted per acre, and replanting is done as

Table 2.11. Machinery Purchase Cost, Hourly Cost of Operation, and Anticipated Annual Use

Machine	Initial Cost	Cost Per Hour	Annual Operating Hours Year 1	Year 2	Year 3	Years 4-8
50-horsepower tractor	$20,000	$4.05	85.20	14.00	21.70	26.70
Four-wheel-drive 3/4-ton pickup truck (cost/mile and miles/acre)	18,500	0.29	500.00	500.00	500.00	500.00
50-gallon, 3-pt.-hitch herbicide sprayer	2,125	1.27	2.00	2.00	1.00	1.00
Post driver	1,500	1.20	11.20			
200-gallon, trailer-hitch pesticide sprayer	6,000	2.82	3.00	4.00	5.70	5.70
6-foot mower and brush chopper	1,700	0.63	2.00	2.00	2.00	2.00
Fertilizer spreader/seed broadcaster	1,800	1.44	0.50			
PTO-driven 12-inch auger	1,400	1.12	47.00			
5-foot flatbed wagon or trailer	1,575	$0.58	15.00		5.0	12.00
Total machinery purchase expense	$54,600					

Machinery Capital Recovery

Machinery investment financed at 8% for 7 years:$54,600 X 0.1921[a] = $10,489

Annual cost per acre (10-acre vineyard): $10,489/10 acres = $1,049

[a]Capital recovery factor for the financing terms specified above.

necessary. Grafted vines are purchased for $2.90 each, and planting requires 20.2 hours per acre (2 minutes per vine). Additional plant preparation may be necessary for trimming the vine's roots and shoots. This operation, if required, should be considered in your own cost analysis. The relatively wide in-row spacing assumes a potentially high-vigor situation as afforded by deep soils and pest-tolerant rootstocks.

The trellis is installed in the first year. Row length in this model vineyard is 440 feet. Shorter rows would result in slightly greater costs, whereas longer rows would slightly reduce costs. The trellis consists of line posts spaced 24 feet apart in the row. The vines will be trained to a bilateral cordon at 42 inches above the ground and spur pruned. In addition to the cordon wire, three pairs of foliage catch wires will be positioned at 50, 61, and 72 inches above ground level. The cost for trellising and trellis labor amounts to approximately $1,400 per acre, or about 24 percent of the total cash expense in year 1.

Machinery cash operating expenses amount to $578 in the first year. Machinery and equipment operation costs are based on agricultural engineering estimates (Table 2.9). It is assumed that a four-wheel-drive ¾-ton pickup truck will

Table 2.12. Cost of Pesticide Program by Year

Spray material[a]	Units	Cost Per Unit	Units Sprayed Per Acre	Year 1 Sprays Per Year	Year 1 Cost Per Acre	Year 2 Sprays Per Year	Year 2 Cost Per Acre	Year 3 Sprays Per Year	Year 3 Cost Per Acre
Fungicides									
mancozeb	lb	$2.35	3.0	2	$14.10	5	$35.25	5	$35.25
captan	lb	2.10	4.0	2	16.80	4	33.60	4	33.60
sulfur	lb	0.19	3.0	2	1.14	5	2.85	5	2.85
bordeaux	lb	2.10	2.0			2	8.40	2	8.40
triadimefon	oz	3.09	4.0	2	24.75	3	37.13	3	37.13
ferbam	lb	1.90	3.0	1	5.70	2	19.62	2	19.62
iprodione[b]	lb	20.00	1.0			3	60.00		
myclobutanil	oz	3.50	4.0			2	28.00	2	28.00
Insecticides									
phosmet	lb	3.95	2.0	2	15.80	2	15.80	2	15.80
carbaryl	lb	3.15	4.0			1	12.60	1	12.60
azinphosmethyl	lb	6.80	2.0					2	27.20
Herbicides									
glyphosate	gal	44.04	0.17	1	7.34	0.08	3.67	0.08	3.67
simazine	lb	2.85	0.9					1	2.85
oryzalin	gal	$64.00	0.3	1	21.33	1	21.33	1	21.33
Total per year					$101.26		$218.25		$286.97

Notes: Consult your Cooperative Extension office for current spray recommendations. The fungicide and insecticide spray program is based on a 10- to 14-day spray interval beginning about April 10 and stopping about September 30. That basic schedule is shortened somewhat during periods of wet weather and is extended up to 21 days during the summer and postharvest period. The actual number of sprays needed will vary from year to year. Spray intervals are extended during the first two years because of the absence of fruit. It is essential to base the pest management program on established insect and disease management principles rather than subscribing to a fixed spray schedule.

[a] Names shown are chemical names, not trade or common names. Formulations and product registrations change from time to time. Always check the pesticide label for specific use directions and legal restrictions. Prices shown are 1994 prices for commonly used formulations.

[b] Iprodione (Rovral) should be used only where botrytis rot is troublesome. It is unlikely that iprodione would be needed in year 3, but it may be useful in subsequent years.

be driven 500 miles per year for various tasks relating to the vineyard. Again, you should adjust this cost if your truck usage related to the vineyard will exceed this amount. Keep in mind that no charges are made in these enterprise budgets for machinery and equipment ownership costs such as insurance, taxes, depreciation, or capital recovery. Annual repair costs are estimated to be 1 to 3 percent of the purchase price.

Year 2

The total operating expense per acre in year 2 is $1,477 (Table 2.2). The vines are pruned and tied in late winter using 10 hours of labor per acre. A strip spray of herbicide is used for weed control in the spring. Row middles are mowed six times during the growing season. A trained laborer will be needed for canopy management operations in year 2. These operations, costing $290 per acre, consist of shoot thinning, shoot tying, and flower cluster removal. Fungicide and insecticide spraying costs of $291 are the next largest cash expense after canopy management in year 2. The interest of $452 on the first year's cash expenses represents the largest charge in the second year's budget.

Year 3

In the vineyard's third year (Table 2.3) a number of the same basic operations are performed as in year 2, with the following exceptions. None of the vines are replanted in year 3 (2 percent of the initial planting was replaced in year 2). Dormant pruning consists of spur pruning and cordon training operations. In the third summer, vine training continues. It includes three shoot positionings, requiring a total of 30 hours per acre, and selective leaf removal, taking 25 hours per acre. The total cash expenses calculated for year 3 are $2,696, and cumulative establishment costs are $9,818 per acre through the third year. A small harvest is expected in year 3 (2 tons per acre), with yields increasing to full production in year 4 (3.5 tons per acre). The grapes are picked by hand. Picking costs are calculated at a rate of $1.25 per 25-pound lug of fruit. The harvest income of $2,300 reduces the net investment at the end of year 3 to $7,518.

Year 4

Slightly less labor is required in year 4 for cordon training and tying than in year 3, but vineyard weed control, fertilization, canopy management, and fungicide and insecticide operations and costs (Table 2.4) are comparable to those for year 3. The total accumulated cash expense in year 4 is $10,252 per acre. The harvest income of $4,025 reduces the net investment at the end of year 4 to $6,227.

Years 5 through 8

Operating expenses in enterprise budgets for years 5, 6, and 7 (Tables 2.5 through 2.7) are similar to those for year 4. Pruning may take longer as vines get older. The final enterprise budget is shown in Table 2.8. A net return of $1,603 per acre is projected for year 8.

Summary

This chapter is intended primarily for the benefit of new and potential vineyard owners and managers who have questions about the economics of growing winegrapes in the mid-Atlantic region. Establishing a commercial vineyard requires a substantial capital investment. The 10-acre enterprise budgets presented in this chapter assume production on an excellent site where the hazards of winter cold injury and spring frosts are minimal and where deer exclusion fencing is not needed. If an inferior site is selected where vines will be subject to freeze losses, wildlife damage, or both, it will be necessary to consider capital expenditures to improve the site. Keep in mind that these site compensation measures will add to the overall cost and that it will take longer to realize a positive return on the vineyard investment. Under the best of conditions, it takes 7 to 10 years to recover the investment in a winegrape vineyard. Table 2.13 summarizes the vineyard establishment and operating costs for years 1 though 8. Table 2.14 shows the net return per acre per year for various crop yield and crop value combinations after year 3.

For the 10-acre Chardonnay vineyard used as an example in this chapter, a positive return of $1,603 is projected in year 8 of the operation. However, the enterprise budgets in this chapter do not include any charges for ownership items such as insurance, taxes, equipment depreciation, or capital recovery. Furthermore, no charges for land costs or for vineyard management have been included. Thus, in comparing the profitability of winegrapes with alternative farm and nonfarm investments, these budgets should be adjusted to reflect projected costs for land, site improvement, various ownership items, and the value of vineyard management. Finally, this analysis ignores any tax advantages associated with vineyard ownership and operation.

Table 2.13. Summary of Vineyard Establishment and Operating Budgets by Year

	Year							
Operation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Site preparation	$ 112							
Vineyard layout	491							
Plants and planting	1,906							
Trellis material	1,482							
Trellis construction	373							
Dormant pruning		$ 75	$ 300	$ 188	$ 188	$ 188	$ 188	$ 188
Weed control	74	70	70	52	52	52	52	52
Replanting		43						
Fertilization	36		22	35	35	35	35	35
Canopy management	273	290	493	493	493	493	493	493
Disease and insect control	101	291	265	325	325	325	325	325
Harvesting costs[a]			640	680	350	350	350	350
Machinery	578	217	254	279	279	279	279	279
Operating interest	217	39	82	82	69	69	69	69
Annual operating expense	5,645	1,025	2,126	2,133	1,781	1,781	1,789	1,789
Accrued interest		452	570	601	498	359	209	47
Harvest income			2,300	4,025	4,025	4,025	4,025	4,025
Net investment	$5,645	$7,122	$7,518	$6,227	$4,490	$2,613	$ 586	–$1,603[b]

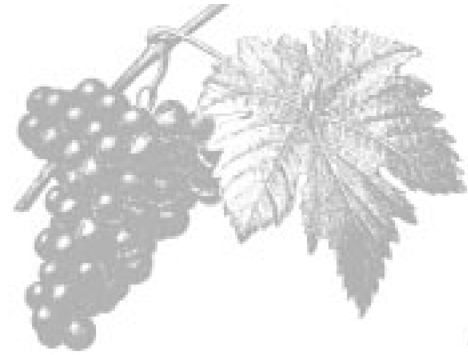
[a] Harvesting costs include 80 harvesting lugs in year 3 and 60 in year 4 at $5.50 each.
[b] The negative number indicates a cumulative net return.

Table 2.14. Comparative Net Returns Per Acre, Per Year, for Various Crop Yield and Grape Price Combinations After Year 3

Yield (tons	Grape Price (dollars per ton)						
per acre)	$800	$900	$1,000	$1,100	$1,200	$1,300	$1,400
2.0	$ -33	$ 167	$ 367	$ 567	$ 767	$ 967	$1,167
2.5	315	565	815	1,065	1,315	1,565	1,815
3.0	663	963	1,263	1,563	1,863	2,163	2,463
3.5	1,011	1,361	1,711	2,061	2,411	2,761	3,111
4.0	1,359	1,759	2,159	2,559	2,959	3,359	3,759
4.5	$1,707	$2,157	$2,607	$3,057	$3,507	$3,957	$4,407

Chapter 3

Grape Varieties



This chapter recommends grape varieties that have demonstrated commercial suitability under diverse growing conditions in both Virginia and North Carolina. Relative acreage, strengths, and weaknesses of each recommended variety are discussed, primarily as they relate to Virginia, where more detailed observations have been made. Because growing conditions and markets are similar in the two states, the same strengths and weaknesses will probably apply to sites in North Carolina.

Recommendations are derived primarily from the collective experiences of numerous commercial growers, not from controlled comparisons in research plots. Furthermore, the strengths and weaknesses cited relate mostly to the viticultural characteristics of the varieties. Winemakers can no doubt assemble their own lists of strengths and weaknesses based on their experiences in the winery and with consumers.

A variety recommended here as "suitable" does not guarantee that the variety will flourish and consistently produce high yields for all growers. Rather, suitable is a relative term. A competent grower at a good site will have a greater probability of success with a suitable variety than with an unsuitable variety.

Cultivars, Varieties, and Clones

A named, cultivated variety is formally referred to as a *cultivar*. However, the more common designation, *variety*, is used here because it is more common in nontechnical publications. Another word frequently mentioned in discussions of winegrape varieties is *clone*. A clone is more specific than a variety. *Clone* refers to one or more vines that originated from an individual vine, which was in some way unique from other vines of the same variety. The unique vine can be propagated vegetatively by taking cuttings. Each plant derived from such cuttings is a clone of the parent plant, and the group of plants can be collectively given a clonal name, such as Chardonnay UCD (University of California, Davis) clone #4. A new clone can arise when someone selects a particular vine that might stand out from other vines of that variety on the basis of greater yields or better fruit quality. The factors contributing to clonal variation are numerous but frequently involve genetic mutations and virus infections. Although more attention is being given to selecting certain clones for certain planting locations, experience with different clones in Virginia and North Carolina is limited. Thus, the following varietal descriptions do not attempt to distinguish among clones within a particular variety. More specific information on viticultural and winemaking characteristics of some common clones is available from the Foundation Plant Materials

Service of the University of California, Davis. (See the references at the end of this chapter.)

Pollination

All of the commonly planted bunch grapes are self-fruitful, meaning that they can be planted in large, contiguous blocks without the need for cross-pollinating varieties. Some muscadine grape varieties (*Muscadinia rotundifolia*) do, however, require a pollinator. Growers interested in muscadine grapes should determine in advance if a pollinator is necessary.

Rootstocks

All vinifera grapes should be grafted to a pest-resistant rootstock. The primary reason for grafting is to provide tolerance of the phylloxera root louse. Phylloxera feed on roots, weakening and killing the vine. Rootstocks can also be used with hybrid and American varieties to impart greater vigor to the scion variety. (The scion is the above-ground, fruiting portion of a grafted vine.) Grafting of nonvinifera vines might be desirable for soils that are inherently low in nutrients or water-holding capacity and where experience has demonstrated low vine vigor.

The most commonly used and recommended rootstock in this region is Couderc-3309 (C-3309). Two other rootstocks, 5BB and SO4, are commonly available but tend to produce larger, more vigorous vines than are desirable for many conventional plant spacing and training systems. Most of the supposed SO4 rootstock currently planted in the East is probably 5C rootstock that was incorrectly named SO4. The true SO4 rootstock, where available, might perform differently. Two other rootstocks suitable for use in Virginia are Mgt 101-14 and C-1616E, although they may be difficult to obtain from nurseries. Numerous other rootstocks are available, some of which have been developed for special soil conditions or to provide resistance to specific soil pests. Readers wishing to further pursue this subject should refer to the rootstock subject matter listed in the references.

Disease Resistance

All commercial grape varieties commonly grown in this region are susceptible to one or more foliar and fruit diseases. The common diseases include black rot, powdery mildew, and downy mildew. Certain cultural practices reduce the severity of these diseases, but economical control can be achieved only with a fungicide spray program. Grape pesticide recommendations are updated by state university pest management specialists and are available through county Cooperative Extension Centers.

Home Grape Production

Some commercial grape varieties are quite suitable for home wine and table grape production, as noted throughout the text.

Grape Markets

It is very important to explore the market for any grape variety thoroughly before considering commercial production. Contact wineries before you commit to a particular variety, and determine what those wineries will be buying in the foreseeable future. Certain grape varieties are relatively easy to grow but lack commercial appeal. On the other hand, a winery might express a strong interest in buying grapes that are difficult to crop consistently (for example, Merlot and Sauvignon blanc). Therefore, unless you are confident that you have an excellent vineyard site or that you can tolerate financial losses during occasional bad years, stick with varieties that have better track records.

White *Vitis vinifera* Varieties

Chardonnay

The most abundant variety in Virginia is Chardonnay, which accounts for about 30 percent of the state's commercial grape acreage. Chardonnay is planted in areas as geographically diverse as the eastern shore, the rolling hills of the piedmont, and the higher elevations along the Blue Ridge Mountains. The fruit ripens about the first week of September in central and eastern areas of Virginia and about one month later at the coolest locations at higher elevations.

STRENGTHS. The winery demand for high quality Chardonnay fruit is currently robust and reflects a similar demand among wine consumers for varietal Chardonnay wines. Chardonnay offers good yields and fruit quality when properly managed. Yields of 3 to 5 tons of high-quality fruit per acre have been achieved consistently by competent growers in good years. Conversion of nondivided canopy training systems to open-lyre, divided canopy training has increased yields without sacrificing fruit quality. Divided canopy training or wide, in-row vine spacing (for example, 8 to 12 feet) should be considered where experience, soil conditions, and moisture availability (especially with irrigation) suggest that vigorous vegetative growth is apt to occur. Vines that consistently produce more than of 0.4 pound of cane prunings per foot of canopy are considered excessively vigorous. Chardonnay has fair to good cold hardiness. None of the common *V. vinifera* varieties possess the cold hardiness of the hybrid or native American varieties. However, there is a range of cold hardiness among the vinifera varieties, and Chardonnay is among the most hardy of those commonly grown in this region.

WEAKNESSES. Chardonnay is one of the first vines to break bud in the spring. Hence, it is subject to occasional frost injury if planted in frost-prone sites. Avoid frost through prudent site selection (see chapter 3) or choose a variety that breaks bud later. Botrytis and other bunch rots can reduce yields in wet years. As with other grafted grapevines, Chardonnay often produces an excessive amount of vegetation for conventional training systems to expose to sunlight. Botrytis and other fruit bunch rots can be severe when fruit is allowed to develop in dense, shaded canopies. Remedial canopy management practices that improve fruit zone ventilation and exposure will reduce the incidence of rot. Those practices vary with training system but include summer hedging of shoot tops, selective removal of shading foliage from fruit zones, and conversion of nondivided canopy training systems to a divided canopy system. (See chapter 6.) Grape berry moth infestations can aggravate bunch rot problems and must be controlled.

Chardonnay

Riesling

Riesling grapes account for about 13 percent of the Virginia grape acreage. Grapes ripen about one week after Chardonnay and tend to retain more varietal character when grown at cooler sites.

Riesling

STRENGTHS. Riesling grapes are among the most cold hardy of the *V. vinifera* grapes commonly grown in this region. Like other vinifera varieties, Riesling is subject to occasional cold injury. Riesling vines, however, often survive cold episodes that injure or kill other vinifera vines. Late bud break gives some insurance against frost injury. Riesling breaks bud in the spring anywhere from 5 to 12 days after Chardonnay. That delay may be of benefit at sites subject to occasional frosts.

WEAKNESSES. The long-term demand for

Riesling by wineries is questionable; Riesling grape prices tend to be somewhat lower than those paid by wineries for other vinifera grapes in Virginia. Compact clusters and high susceptibility to berry cracking can lead to severe rot problems, particularly when rains occur just before harvest. The canopy management practices previously described for Chardonnay are helpful but do not eliminate the problem. Riesling productivity is among the lowest of commonly grown varieties in Virginia. Research in Virginia indicated that in many vineyards low productivity can be attributed to bud necrosis, which is the abortion and drying of buds during the summer of their development. The causes are not known, but research has shown that high rates of shoot growth and poor light exposure of the developing buds increase the incidence of necrotic buds. Cordon training and spur pruning are used in Virginia to compensate for bud necrosis because the first few buds of the cane are often unaffected.

Cabernet Sauvignon

Red *Vitis vinifera* varieties

Cabernet Sauvignon

About 15 percent of Virginia grape acreage is planted to Cabernet Sauvignon. One of the latest maturing varieties, Cabernet fruit is harvested two to three weeks after Chardonnay.

STRENGTHS. The demand by wineries for high-quality Cabernet Sauvignon fruit for use in making varietal wine is currently robust and is expected to remain strong. Bud break with Cabernet Sauvignon occurs about 10 to 14 days after Chardonnay, reducing the likelihood of frost injury. This variety produces good yields if properly managed. Yields of 3 to 5 tons per acre are not uncommon with well-managed Cabernet vineyards. As with Chardonnay, divided canopy training systems or wide in-row vine spacing should be seriously considered to accommodate growth and increase fruit yields. Cabernet fruit is decidedly more resistant to cracking and rots than many other commonly grown varieties.

WEAKNESSES. Cabernet Sauvignon is perhaps the most vigorous variety commercially grown in this region, often resulting in excessive vegetative growth. This high vigor, if not managed, can cause canopy shading and related problems with fruit quality (poor fruit pigmentation, high pH, and reduced varietal aroma). Research from other viticultural areas and experience in Virginia suggest that canopy management practices such as summer hedging, selective leaf removal, and canopy division are appropriate means of dealing with excess vegetation in existing vineyards. Cabernet Sauvignon is susceptible to winter cold injury. The dormant buds and wood (trunks, arms, and canes) can be injured by temperatures that normally do not harm Chardonnay or Riesling vines. For this reason, Cabernet Sauvignon should be planted only on excellent sites where temperatures rarely drop below –5°F. Bunch stem necrosis can reduce yields. This form of necrosis is a poorly understood disorder that may occur around the time of bloom (in which case it is called early bunch stem necrosis) or in late summer as the fruit begins to mature. The disorder is not unique to this region. Late-season bunch stem necrosis has been observed widely and frequently in Virginia. Conditions that apparently promote the disease include extremes of moisture, high humidity, overcropping, excessive vine vigor, and poor vine nutrition. Partial control has been claimed in some viticultural regions by foliar applications of magnesium sulfate, directed at the clusters, during mid- to late summer. Still other researchers have found evidence that the disorder may be aggravated by accumulation of toxic, nitrogenous products in the affected tissue. Aside from ensuring optimal mineral nutrition (see chapter 9), Cabernet growers should explore options for limiting shoot vigor, vegetative growth, and fruit zone humidity. Those options are consistent with planting densities and training systems that permit more shoots per root system without increasing shoot density per unit length of canopy.

Cabernet franc

Another red Bordeaux variety, Cabernet franc has gained acreage in this region within the last few years. Vegetative growth, yields, and fruit quality are similar to Cabernet Sauvignon. One distinction between these varieties, however, is the somewhat greater cold hardiness of Cabernet franc (Wolf and Cook, 1991).

STRENGTHS. Cabernet franc produces good yields if properly managed. The comments made previously about Cabernet Sauvignon also apply to this variety. The fruit has good rot resistance. Cabernet franc fruit ripens 3 to 10 days earlier than Cabernet Sauvignon fruit and is fairly resistant to bunch rots. Grower experience as well as controlled cold hardiness comparisons of dormant buds (Pool et al., undated; Wolf and Cook, 1991) indicate that Cabernet franc might have up to several degrees Fahrenheit greater cold hardiness than Cabernet Sauvignon. In some vineyards, that small degree of superior hardiness can translate to more consistent yields. Cabernet franc is a relative newcomer to Virginia viticulture, but demand for the fruit is anticipated to remain steady or increase in future years.

WEAKNESSES. Vegetative growth is often excessive. The comments made about Cabernet Sauvignon growth characteristics also apply to Cabernet franc. Leafroll virus is prevalent in much of the propagative stock and can reduce yields, fruit quality, and perhaps the cold hardiness of affected vines. Leafroll is present in as much as 30 percent of the commonly available Cabernet franc planting stock. Leafroll symptoms become obvious in mid- to late summer as a downward rolling of leaf margins and a reddening of the interveinal regions of leaves. It is advisable to seek disease-free certified nursery stock or to collect budwood from vines that were marked during the growing season as being visually free of leafroll symptoms. The purchase of "certified disease-free" nursery stock has not always prevented the introduction of leafroll-affected vines. This variety exhibits earlier bud break than Cabernet Sauvignon. Although this is not a serious weakness, earlier bud break is of concern on sites subject to frost injury. As with Cabernet Sauvignon, bunch stem necrosis can reduce yields.

Cabernet franc

White Hybrid Varieties

Seyval

Seyval

Seyval represents about 7 percent of current Virginia grape acreage. The fruit ripens around the same time as Chardonnay. Bunches can be exceptionally large and are often compact. Seyval is also recommended for home winegrape production.

STRENGTHS. Seyval offers excellent cold hardiness. As a group, the hybrid varieties — including Seyval — possess about 5 to 10 degrees Fahrenheit greater midwinter cold hardiness than any of the common vinifera varieties. Seyval produces excellent yields if properly managed; yields of 5 or 6 tons per acre are not uncommon. The larger and more consistent yields can largely offset the lower price usually paid per ton. However, many growers have mistakenly assumed that Seyval is easier to grow than vinifera varieties. In reality, large crops of high-quality fruit are possible only if vine size is maintained and prudent canopy management practices are used.

WEAKNESSES. The average price paid by wineries for Seyval is roughly one-half that paid for vinifera grapes. Bud break occurs early, around the time of Chardonnay bud break, which can result in frost injury. Well-managed Seyval vines, however, have fairly fruitful secondary or base buds, and yields of 3 to 5 tons per acre have been attained from secondary shoots after severe frost injury to primary shoots. The high fruitfulness of Seyval can lead to overcropping of small or weak vines, which is probably the most common mistake growers make with this variety. The result is chronically stunted vines, low yields, and poor fruit quality. Overcropping can be avoided by proper (relatively severe) dormant pruning, followed by additional crop control consisting of shoot thinning to no more than four shoots per foot of canopy, fruit cluster thinning, or a combination of the two. Regular nitrogen fertilizer applications are generally required with nongrafted Seyval vines to maintain vine vigor. The compactness of Seyval fruit clusters can lead to berry splitting and associated bunch rots, particularly with rains just before harvest. Fruit bunch rots can be severe. Rots can be reduced by (1) using canopy management techniques that improve fruit zone ventilation, (2) thinning clusters after fruit set rather than before, (3) using an effective disease control spray program, and (4) controlling infestations of grape berry moth and other fruit-damaging insects.

Vidal blanc

Vidal blanc

Like Seyval, Vidal blanc represents about 7 percent of current Virginia grape acreage. This variety is also recommended for home winegrape production.

STRENGTHS. Vidal blanc has excellent cold hardiness. The comments on hardiness for Seyval also apply to Vidal. This variety provides excellent yields if properly managed; yields of 4 to 6 tons per acre are common. The problems inherent with overcropping, as described for Seyval, can also affect Vidal to some extent. Vidal is a very late bud-breaking variety. This attribute, as well as its relatively good cold hardiness, gives Vidal an advantage on sites subject to spring frosts. The fruit matures late and is more resistant than Seyval to fruit bunch rots.

WEAKNESSES. Like Seyval, Vidal may produce larger crops than the vine can mature, which can lead to overcropping. The results of overcropping and the practices needed to avoid it are similar to those described for Seyval. Viruses can be prevalent. Many Vidal plantings in Virginia contain vines infected with tomato and tobacco ring spot virus. These viruses weaken and often kill the infected vines. Both viruses can be introduced in infected stock. The viruses can also be transmitted to clean plants in the vineyard by soil nematodes, which acquire the viruses from infected weeds or previous crops. It is advisable to buy certified disease-free vines if possible. Infection of clean stock can be minimized by keeping the vineyard free of broadleaved weeds such as dandelion and plantain. Clean stock can also be grafted to C-3309 rootstock, which possesses good field resistance to tomato ring spot infection.

Red Hybrid Varieties

Chambourcin

Chambourcin

The fruit of Chambourcin has been used to produce varietal wines and has also been used in blends with other red-fruited varieties. In Virginia the acreage of Chambourcin is less than 5 percent of the total grape acreage, but this variety is perhaps the most popular red hybrid in both Virginia and North Carolina. The fruit matures in midseason.

STRENGTHS. Chambourcin has good winter cold hardiness, similar to that of Seyval. Fruit bunch rots have not been particularly troublesome.

WEAKNESSES. Chambourcin's growth is weak and yields are poor unless the vines are properly fertilized. Periodic leaf petiole sampling and observations of vine size and vine vigor are recommended to determine nutrient status. Routine applications of nitrogen are usually needed to maintain vigor, vine size, and yields. The long-term demand by wineries is uncertain. As with any variety, be sure that a market exists for projected yields before ordering grapevines.

Winegrape Varieties Not Recommended

A number of winegrape varieties have received commercial evaluation but are generally not recommended in Virginia or North Carolina because of one or more viticultural concerns.

The following varieties have seen some cultivation under a wide range of regional growing conditions. In some years, yields and quality can be outstanding and the resultant wines can win prestigious awards. However, when the experiences of many growers are replicated over time, the good years are the exception, and the income fails to pay the bills.

Merlot

For those fortunate enough to be able to grow and crop Merlot, the rewards have often been outstanding wine quality. Merlot is quite sensitive to cold injury and crown gall and can be recommended only for those few excellent sites where experience has demonstrated that winter injury is not a serious threat. Much of the commonly available stock is infected with leafroll virus. Merlot fruit is highly susceptible to bunch rots, which often necessitates early harvesting and less than optimal fruit quality.

Sauvignon blanc

The principal liabilities of Sauvignon blanc are its susceptibility to winter cold injury as well as its high susceptibility to fruit bunch rots.

Gewürztraminer

The fruit of Gewürztraminer is very prone to rot, generally before it is ripe. Also, varietal fruit character can be lacking in hot seasons, and fruit pigments may develop unevenly in shaded canopies.

Pinot noir

Research is needed in this region to evaluate some of the numerous Pinot noir clones that are available. The principal limitation seen with Pinot noir currently being grown in Virginia is the tendency for the fruit to rot before it is ripe. Vintners interested in sparkling wine production might have justification for considering this variety, though. Fruit destined for sparkling wine production is typically harvested at lower sugar and higher pH levels than is fruit used for still wine production. That earlier harvest could avoid many of the potential rot problems.

Other Hybrid Grapes

Chancellor, Foch, Baco noir, DeChaunac, Aurore, Villard blanc, Villard noir, Rayon d'Or, Chelois, and Rougeon are grown in commercial quantities in several regional vineyards. Viticulturally, some of these varieties perform quite well and are relatively easy to manage. Some can be recommended for home wine production. Relatively few wineries, however, are currently using these grapes. Those that do use these varieties produce the bulk of the fruit themselves. Therefore, because of uncertain markets, these varieties are not generally recommended.

Native American Grapes

Table Grape Varieties

Himrod
Interlaken
Lakemont
Reliance

With a few notable exceptions, such as Niagara and Delaware, none of the native American grape varieties contribute significantly to regional winemaking. Thus, the native American grapes are generally not recommended for commercial winegrape production.

Table grapes represent less than 5 percent of the total Virginia grape acreage and probably figure comparably in the North Carolina grape industry. Most of the present acreage comprises seeded varieties such as Concord, Niagara, and Fredonia. Interest in seedless table grape varieties has increased in recent years, particularly in light of consumer surveys that documented preference for seedlessness. Thus, the following discussion considers seedless varieties first, followed by recommendations for a few seeded varieties.

As with winegrape varieties, the market for potential crops should be examined before planting any grapes. Owing to the small volume of crop produced by table grape operations, most crops are marketed directly, as opposed to being sold via wholesale channels. Direct markets include roadside stands, pick-your-own operations, farm markets, and grocery stores.

Seedless Table Grapes

The following seedless table grape varieties have demonstrated commercial potential in Virginia. Note that for all varieties one or more potential detracting qualities are described. The occurrence of such defects varies from site to site and year to year; defects may or may not be evident under your growing conditions. As a general observation, seedless table grapes are subject to severe bird depredation. For this reason the use of some form of bird protection, such as bird netting, is advisable.

Grape berry color is customarily described as white, red, blue, or black. White fruit varies from pale green to amber, depending on variety and degree of ripeness. Similarly, red-fruited varieties can vary from muddy green to deep red, depending upon temperature and light exposure.

Noticeable seeds can be found in so-called seedless grapes. Seeds can be soft and barely noticeable or they can have hard seed coats.

Himrod

Himrod, Interlaken, Lakemont, and Romulus are sister varieties resulting from a cross between Ontario and Thompson Seedless made at Geneva, New York, in 1928. Ontario is an American-type grape and Thompson Seedless is a vinifera. Himrod was named in 1952. It is white-fruited and ripens early, compared to other seedless grapes (late July in northeast Virginia). Fruit quality is excellent and berry size can be increased with cluster thinning, gibberellic acid, cane girdling, or a combination of these methods. Berry pedicels, the small stems that attach individual berries to the cluster, tend to be brittle, and berry shelling can result from excessive cluster handling or prolonged storage.

Interlaken

Interlaken was named in 1947. The fruit is white and ripens as early as, if not earlier than, Himrod. Fruit quality is excellent and responds to berry size enhancement practices. Interlaken vines are moderately susceptible to winter cold injury and should not be planted on sites prone to severe winter temperatures.

Lakemont

A white variety, Lakemont ripens about one week after Himrod. Fruit quality is good to excellent, and the fruit reportedly stores well. A potential problem with Lakemont is the development of uneven berry size on a given cluster and a smaller berry, on the average, than other table grapes.

Reliance

Reliance is a red-fruited variety released by the Arkansas breeding program in 1983. Fruit ripens at about the same time as Himrod and has an excellent labrusca-type flavor. Aroma and flavor can become overbearing if the fruit is allowed to overripen. Many feel that Reliance is perhaps the finest-flavored eastern table grape currently named. The vines are quite vigorous, are exceptionally cold hardy, and can produce extremely large crops if properly managed. Berry cracking has been a problem in cases where heavy or prolonged rains occur around harvest. Noticeable seed traces are observed in some years. Experience with Reliance and other red-fruited varieties in Virginia indicates that shaded clusters (for example, those shaded by canopy foliage) do not develop berry color as well as exposed clusters. Vine training and other aspects of canopy management should be adjusted accordingly.

Vanessa

A red-fruited variety, Vanessa was introduced in 1985 at the Vineland Research Station in Ontario, Canada. The fruit matures about a week after Himrod. The berries are attractive, very firm, and have good flavor. Fruit clusters are rather small, and vines in Virginia have tended to be of low vigor. Trials with grafted vines are in progress. Some berry splitting has been observed in wet years. Seed traces are noticeable in some years.

Einset

A red-fruited variety, Einset was named at Geneva, New York, in 1985. The fruit is resistant to cracking and ripens at approximately the same time as Himrod. Fruit quality is excellent. The flavor is labrusca-like but not as pronounced as that of Reliance. Clusters reportedly respond well to cultural improvement practices and store well. Commercial experience with Einset in Virginia and North Carolina is limited.

Glenora

A black-fruited variety, Glenora was released at Geneva, New York, in 1977. Berries and clusters are relatively small but respond to girdling and gibberellic acid. Fruit flavor can be excellent. A potential defect with Glenora is inconsistent fruit quality: in some years the fruit has very little flavor. Another occasional problem with Glenora has been the occurrence of dehydrated berries on the cluster, which might be due to berry cracking and subsequent drying.

Mars

A blue-black grape, Mars was released by the Arkansas breeding program in 1985. Flavor is labrusca-like, similar to the pronounced labrusca character of Concord. Clusters tend to be smaller than average. Vines are vigorous and relatively resistant to common diseases, making this variety attractive to home grape producers. Commercial trials with Mars in Virginia and North Carolina are lacking.

Unsuitable Seedless Varieties

The following seedless table grapes are considered unsuitable for commercial planting because of one or more defects. Again, these recommendations attempt to cover a broad geographic area. Defects observed at some sites might not be a major problem at your site. Thus, if planting space exists, you might wish to plant a few of these vines on a trial basis. Do not make major commitments, however, until the vines are five or more years old. Weaknesses in character may not appear until the vines mature.

Romulus

This variety is another white-fruited sister of Himrod, Lakemont, and Interlaken. Fruit ripens up to two weeks after Himrod. The primary objections to Romulus are its small berry size and mediocre fruit quality.

Vanessa

Einset

Glenora

Mars

Romulus

Suffolk Red

Remaily
Canadice
Venus
Concord
Niagara
Seneca
Steuben

Suffolk Red

Although it can have excellent flavor, the chief complaints about Suffold Red are its poor fruit coloration in some years and poorly filled clusters.

Remaily

The clusters of Remaily produce many shot-sized berries, and the flavor of this white-fruited variety is mediocre under Virginia growing conditions. The berries are also subject to abrasion and sunburning, which detract from appearance.

Canadice

Despite excellent flavor, Canadice fruit clusters tend to be overly compact, which leads to berry cracking and subsequent rot. Furthermore, the red pigment of the berries does not develop consistently in all seasons.

Venus

An extremely high-yielding, blue-black fruited variety, Venus was produced by the Arkansas breeding program. Vines are quite hardy and vigorous. Venus berries tend to be tough-skinned, retain noticeable seed traces, and have only mediocre flavor. Thus, although the fruit is attractive and abundant, it generates few repeat customers.

Vinifera Table Grapes

As a group, the vinifera table grapes, such as Flame Seedless and Thompson Seedless, have not exhibited sufficient cold hardiness to warrant commercial planting in this region. Furthermore, the fruit is prone to rot, and the clusters need to be chemically or mechanically regulated for increased berry size.

Seeded Table Grapes

Several seeded table grapes enjoy commercial acceptance and many are well-suited for home wine and table grape production. Some are eaten fresh, whereas others are processed for juice and jellies. Seeds are a minor concern in the latter case. Most of these varieties have slip-skin fruit—that is, the skins do not adhere to the flesh.

Concord

A blue-black variety, Concord is probably the most commonly grown backyard grape in the eastern United States and the dominant table grape in Virginia. Concord vines are hardy, vigorous, and productive; they perform well in somewhat acidic soils. Concord's principal strength is consumer recognition. Its primary defect is uneven fruit coloration. This problem can be due to overcropping, canopy shade, and perhaps heat; the warmer areas of the state have more problems with uneven fruit color development than do cooler regions. An informative guide to commercial Concord production (Zabadal et al., 1988) is cited in the references.

Niagara

A white-fruited variety, Niagara is used for fresh consumption, jellies, and even wine. The vines are vigorous and hardy, and this variety is adaptable to a wide range of soil conditions. Like many of the American-type varieties, the Niagara fruit flavor is strongly labrusca in character.

Seneca

Seneca bears white-fruited berries that are firm and of excellent flavor. The vines are vigorous and produce large crops if properly managed. The fruit ripens early, around the first week of September in northern Virginia.

Steuben

The fruit of Steuben is bluish black and possesses a distinctive spicy flavor. Steuben vines are vigorous and productive. Fruit coloration can be nonuniform if vines are overcropped.

Many other seeded table grapes have been tried in limited plantings in Virginia and North Carolina. Some have commercial potential, but that potential should be explored initially with small test plantings.

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Sources of Grapevines

The following listing of grapevine suppliers is provided as a convenience to readers and does not imply endorsement of their products nor does the failure to list other suppliers imply inferiority of their products. *Readers are strongly encouraged to consult trade magazines or other sources of nursery advertisement for a current listing.*

KEY TO VARIETIES

A denotes native American varieties
V denotes vinifera varieties
H denotes hybrid varieties
T denotes seedless table varieties
R denotes rootstocks

American Nursery (V,H,R)
Rt. 1 Box 87B1
Madison, VA 22727
(703) 948-5064

Blossomberry Nursery (T)
Rt. 2 Box 158A
Clarksville, AR 72830
(501) 754-6489

Boordy Nursery (H)
Box 38 - 7812 Ruxwood Rd.
Riderwood, MD 21139
(410) 823-4624

Congdon & Weller Wholesale Nursery (A,T)
Mile Block Rd.
North Collins, NY 14111
(716) 337-0171

Concord Nurseries, Inc. (A,V,H,T)
10175 Mile Block Rd.
North Collins, NY 14111-9770
(800) 223-2211
(716) 337-2485

Foundation Plant Material Service (A,V,
H,T,R)
University of California, Davis
Davis, CA 95616
(916) 752-3590

Grafted Grapevine Nursery (V,H)
2399 Wheat Rd.
Clifton Springs, NY 14432
(315) 462-3288

Dr. Konstantin Frank Nursery (V)
9749 Middle Rd.
Hammondsport, NY 14840
(800) 320-0735
(607) 868-4884

Mori Nurseries, Ltd. (V,R)
RR 2, Niagara on the Lake
ONT LOS 1J0 Canada
(905) 468-3218

Carl Remkus Nursery (A,H,R)
858 Bank St.
Painesville, OH 44077
(216) 354-8817

Sonoma Grapevines, Inc. (V,H)
1919 Dennis Lane
Santa Rosa, CA 95403
(707) 542-5510

Sunridge Nursery (V,R)
441 Vineland Rd.
Bakersfield, CA 93307
(805) 363-8463

University of Texas Lands (V)
PO Box 553
Midland, TX 79702
(915) 684-4404

Walter S. Volz Vinifera Vineyard and Nursery (V)
109 Gibson St.
Bath, NY 14810
(607) 776-2270

Herman J. Wiemer Vineyard, Inc. (V)
Rt. 14 Box 38
Dundee, NY 14837
(607) 243-7971

Chapter 4

Vineyard Site Selection

Grapes grown in Virginia and North Carolina are sometimes exposed to unfavorable climatic conditions and biological pests that can reduce crops and injure or kill grapevines. Climatic threats include low winter temperatures, late spring frosts, excessive summer heat, and unpredictable precipitation. Biological pests include fungal pathogens and insects that attack the foliage and fruit of vines, as well as birds, deer, and other wildlife that consume fruit and shoots. Vineyard site selection greatly affects both the frequency and severity of these problems and is therefore one of the most important factors affecting profitability in viticulture.

This chapter describes the characteristics of good vineyard sites and identifies site features that are liabilities to profitable grape production. In practice, vineyard site selection involves compromises; there are few sites ideally suited to grape production in all respects. Furthermore, there are two general categories of individuals that will choose a site for vineyard establishment: those who already own their land and those who are seeking to purchase land on which to grow grapes. The concepts described in this publication apply to both categories. However, those who understand vineyard site selection concepts and purchase land specifically for grape production have greater flexibility than those who are restricted to choosing the best location on a site that they already own. Those who are interested in eventually establishing a winery should also recognize that the best vineyard sites might not necessarily be the most accessible to potential customers.

This chapter discusses three aspects of site selection: climate and topography, soil, and proximity to potential pests. Climate and topography are discussed together because topography has such a profound impact on the local climate of a vineyard. Although the discussion is slanted towards winegrape production, the basic concepts of site selection described here apply to both winegrapes and table grapes.

Climate and Topography

Climate refers to the prevailing weather of a region or site. The climate of a vineyard is influenced by temperature, precipitation, winds, and other meteorological conditions. The proximity of large land forms (for example, mountains) and large bodies of water also affects a site's climate.

The importance of site selection becomes clear when we examine the climatic factors that can adversely affect grape production and grape quality in this region.

1. Extreme heat can reduce grape and wine quality, particularly after the onset of rapid fruit ripening (véraison). In general, wines produced from grapes grown in a hot climate can lack the fruitiness and complexity characteristic of wines from the same variety grown in a cooler climate. Many sites in Virginia and North Carolina, particularly those of the piedmont and coastal areas, experience very hot growing seasons. Selected climatological indices for 10 Virginia cities are shown in Table 4.1. Use the data of Table 4.1 only for relative comparisons. Climatological data from your own vineyard site can differ significantly from those of nearby weather reporting stations, particularly in the case of temperature extremes.

A commonly used index of the relative warmth of a grape-growing region is the cumulative growing degree days (GDD) between April 1 and October 31. That index was refined for grapevines at the University of California, Davis, and was used to define five regions (I to V) (Winkler et al., 1974). Using that system, we can see that many of the sites listed in Table 4.1 would be classified as regions III or IV. Another viticultural index of a region's temperature is based on the mean temperature of the warmest month — July in our case (Smart and Dry, 1980). Using that index, almost all areas of Virginia and North Carolina would be classified as either a hot or very hot grape growing region.

2. Fluctuating temperatures characterize winters in Virginia and North Carolina, except perhaps in the coastal areas. Occasionally, temperatures are cold enough to injure vines, particularly the cold-tender *Vitis vinifera* varieties. The potential for cold-injury is increased when relatively warm falls and early winters are followed by rapid or extreme temperature drops in midwinter.

3. Spring frosts that occur after grapevines have broken bud and commenced shoot growth are not uncommon. Frosts can kill shoots and significantly reduce the fruit crop for the year.

Table 4.1 Selected Climatological Indices for 10 Locations in Virginia

Elev.[1]	Station[2]	Mean Daily Temp. in July Max.	Mean Daily Temp. in July Min.	Record Low	Days Over 90°[3]	FFP[4]	GDD[5]	UCD Class[6]	MTWM[7]
2000	Blacksburg	83	59	-12	7	161	2813	II	Hot
1510	Penn. Gap	85	61	-15	16	164	3356	III	Hot
1385	Staunton	85	62	-8	17	175	3237	III	Hot
1200	Luray	87	60	-10	30	154	3237	III	Hot
870	Charlottesville	87	67	-2	31	211	3952	IV	Very hot
760	Winchester	87	64	-10	25	185	3544	IV	Very hot
420	Culpeper	88	65	-14	36	181	3797	IV	Very hot
100	Fredericksburg	90	64	-10	49	178	3875	IV	Very hot
70	Williamsburg	88	67	-3	39	192	4141	V	Very hot
22	Suffolk	88	68	+4	37	208	4204	V	Very hot

Source: NOAA Climatography of the United States No. 20: Virginia, 1951–1980.

[1] Elevation (of recording instrumentation) in feet above sea level.

[2] Use caution when extrapolating data. Climatic conditions can be expected to differ substantially between station instruments and sites only a few miles apart.

[3] Average number of days per year when daily high temperature is 90°F or greater.

[4] Average frost-free period in days (Crockett, 1972).

[5] Cumulative growing degree days (50°F base) for the period from April 1 through October 31.

[6] Grape region classification number based on University of California, Davis system of classification (Winkler et al., 1974).

[7] Mean Temperature of the Warmest Month (July) system of classification of grape growing regions (Smart and Dry, 1980).

4. A hot, humid growing season promotes the incidence of disease. Excessive moisture in the fruit maturation period (late August to early October) often causes berry splitting and fruit decay.

Appropriate variety selection, timely pesticide application, conscientious vineyard management, and even wind machines and sprinkler irrigation can reduce the impact of winter cold, spring frosts, and diseases. However, prudent site selection is the most effective and economical means of adapting to the region's capricious weather.

Climatologists refer to the climate of a large geographic region as the *macroclimate* of that region. Most of Virginia and North Carolina, for example, are dominated by a *continental macroclimate*. Continental climates have temperature and precipitation patterns that are modified by large land masses (continents). For example, most high-pressure frontal systems that affect our region have first moved across Canada or the Midwest. One feature of a continental climate is air temperatures that can fluctuate rapidly from day to day because land does not readily affect, or buffer, air temperatures. *Maritime climates*, on the other hand, are macroclimates directly influenced by their proximity to large bodies of water. Basically, warm water tends to warm colder air and cold water cools warmer air. Water absorbs heat from the sun and releases that heat and moisture to the atmosphere. Thus, cold air that blows across seas, unfrozen lakes, and other large expanses of water in the winter is warmed and, in turn, warms air temperatures on the leeward side of the water. The moisture absorbed over open water is also likely to affect precipitation patterns on the leeward side. The depth and salinity of bodies of water determines, in part, how much heat they absorb and how much heat they can release before freezing. As air temperatures rise in the spring, large bodies of water warm at slower rates than the surrounding land. Air is thus cooled as it blows over cold water. The cooled air retards spring plant development on the leeward side of the water and reduces the risk of frost injury. The fruit-growing regions bounding the Great Lakes benefit from their proximity to those deep, expansive lakes. Similarly, the temperature-moderating influence of the North Sea contributes to the success of grape growing in northern Germany at a latitude comparable to that of Hudson Bay in Canada. In Virginia and North Carolina, the tidewater and eastern shore counties are subject to a maritime climate because of their proximity to the Atlantic Ocean. No other bodies of water in Virginia or North Carolina are large enough to affect regional climate significantly.

Mesoclimate, or the local climate of a site, is more specific than the macroclimate. The mesoclimate is primarily the climatic conditions within 10 feet of the ground. Climatologists frequently use the term *microclimate* to describe the climate in this zone; however, we will reserve the term *microclimate* to describe, in the next paragraph, an even more specific climate. A site's mesoclimate is affected by factors such as the compass orientation of the site (aspect), the degree of inclination (slope), the relative elevation, and barriers to air drainage.

Microclimate as used here refers to the very specific environment within grapevine canopies. Grapevine canopies consist of the shoots — stems and leaves — present during the growing season. The microclimate within vine canopies can be significantly different from that outside the canopy, particularly with respect to the quantity and quality of sunlight, air temperature, wind speed, and humidity. Typically, the interior region of dense vine canopies will be shaded, will be more humid, and will have slower air movement than will the climate at the exterior of the vine canopy. Experienced grape growers recognize the impact of canopy microclimate on fruit quality and use canopy management practices that promote a favorable canopy microclimate. (See chapter 7.)

Temperature

Three aspects of temperature should be considered in selecting a vineyard site: the potential for spring and fall frosts, midwinter low temperatures, and summer heat.

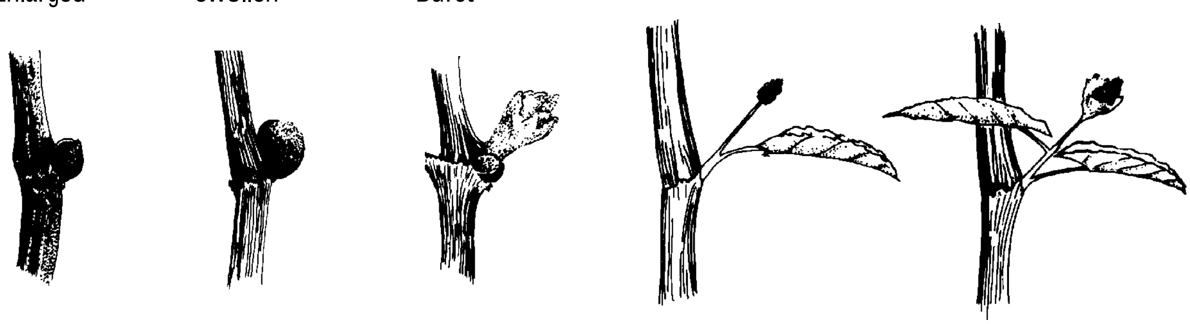
Frost Avoidance

“It is incomprehensible that even today [1966] the most fundamental laws of microclimatology are disregarded time and again, when new orchards are laid out at great cost in notable frost hollows.” Rudolf Geiger (1966) referred to orchard establishment when he issued that statement, but the same concern can be applied to vineyard establishment. To borrow another statement, the best time to protect a vineyard against frost damage is when the vineyard site is being selected. Spring frosts chronically and significantly reduce crops in some vineyards. The problem is most acute when unseasonably warm temperatures promote earlier than normal budbreak and shoot growth. Spring frosts do not generally kill the vine; secondary shoots soon break bud and produce sufficient foliage to maintain vine health. Even a second frost can be compensated for by growth of latent buds on the vine. However, secondary shoots typically have less than half the fruiting potential of primary shoots, and latent “base” buds usually have no preformed fruit clusters. There are exceptions: interspecific hybrid varieties (for example, Seyval and Vidal blanc) often have very fruitful secondary and base buds. Thus, the consequences of a frost are not as severe with most hybrid varieties as they are with vinifera varieties.

Two basic forms of frost can occur: one is termed an *advective freeze* and the other is termed a *radiational freeze*. In both cases, vine injury occurs if susceptible tissues (for example, green shoots) are cooled below a temperature critical for their survival. The critical temperature for tissue freezing varies with the stage of bud development in the spring and also with the amount of moisture in the air or the presence of dew on the tissue. However, fully emerged shoots rarely withstand temperatures below approximately 28°F (Figure 4.1).

Figure 4.1 Critical temperatures of Pinot noir buds and shoots at six stages of development in spring.

STAGES	Dormant Enlarged	Dormant Swollen	Shoot Burst	First	Second



CRITICAL TEMPERATURES FOR BUDS AND SHOOTS

	Dormant Enlarged	Dormant Swollen	Shoot Burst	First	Second
50% Killed	–14.0°C 6.8°F	–3.4°C 25.9°F	–2.2°C 28.0°F	–2.0°C 28.4°F	–1.7°C 28.9°F
None killed	— —	— —	–1.0°C 30.2°F	–1.0°C 30.2°F	–1.0°C 30.2°F

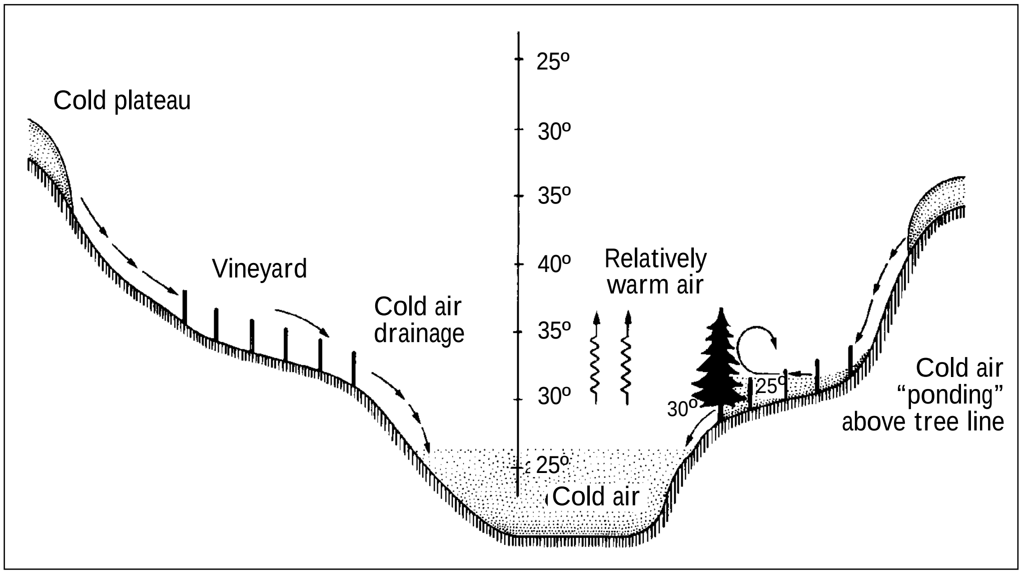


Figure 4.2 Effect of vineyard site topography on air temperature stratification during a radiational cooling period characterized by calm winds and clear skies.

Advective freezes are associated with the passage of large frontal systems of cold air. Generally, the air is turbulent, and little if any stratification of air temperature occurs with changes in elevation. Radiational frosts, by contrast, are much more common and occur during calm weather when skies are clear. Radiational frosts occur as the earth loses heat to the sky during the night. As the ground cools, it also cools the air immediately next to the ground. Plants are frosted if they are growing in that zone of cold air and if the air is cold enough to freeze susceptible tissues. The ground continues to lose heat to the sky throughout the night so that the coldest air temperatures are usually recorded just before dawn. Cloud cover tends to retard the loss of heat to the sky.

Cold air is heavier than warm air and will flow downhill, much like a liquid. Warm air, in turn, is displaced to a higher altitude. The rise in temperature with increase in elevation is referred to as a temperature inversion and is illustrated in Figure 4.2. Above the warm air layer, air temperatures decrease with increased altitude. The relative elevation of a proposed vineyard will have a major impact on the frequency of frost damage. Vineyards located in low frost pockets will be affected by frequent frosts; vineyards located at higher elevations, relative to surrounding topography, will be affected by fewer spring or early fall frosts. Most of us have experienced the ponding of cold air in low areas by strolling, at dusk, from a high hill into an adjacent creek-bottom or gully. The decrease in air temperature as we move downhill is most dramatic on calm, clear evenings. The relationship between relative elevation and air temperature is illustrated in Figure 4.2. The figure also illustrates how barriers to cold air drainage can create localized cold spots in a vineyard. Where possible, vegetation or other impediments to cold air drainage should be removed below the proposed vineyard site. The concept of locating vineyards only on sites affording good cold air drainage cannot be overemphasized.

The effect of local topography on air temperature can be demonstrated by positioning thermometers that record maximum and minimum temperatures in shelters at various elevations on a proposed vineyard site. Two or three recording thermometers, which cost about $25 each, can provide considerable data on temperature variations at a site. The thermometers should be mounted about 5 feet above the ground and should be shielded from the sky with a roof painted white. It is not unusual to find temperature differences of 3° to 5°F over a 50-foot difference in elevation.

In addition to the relative elevation of a site, the absolute elevation can also affect the frequency of damaging spring and fall frosts. For example, grower experience and historical weather data reveal that the frequency of damaging spring frosts in the piedmont and Blue Ridge Mountain areas of Virginia is greater at sites below 800 feet above sea level than at elevations of 800 to 1,800 feet, assuming that the higher sites also have good relative elevation. At elevations greater than 1,800 feet, the benefits of increased elevation are lost in those areas.

Frost protection through energy input is an option for less-than-ideal sites but is expensive. Frost protection methods include the use of wind machines, heaters, sprinklers, and chemical sprays that may temporarily increase the freezing resistance of tissues. None of these methods is totally effective.

Grapevines require a minimum of about 165 frost-free days to mature their crop and to cold-harden (acclimate) their tissues before a killing frost occurs. Most sites in Virginia and North Carolina will meet that minimum requirement (Table 4.1), but it would be wise to check with your local Cooperative Extension Center if you are in doubt about the length of your growing season. Grape varieties such as Cabernet Sauvignon that mature their fruit and wood relatively late in the season should be avoided in areas subject to early fall frosts.

Minimum Winter Temperatures

One of the chief limitations to grape production in this region is damage to vines resulting from severe midwinter low temperatures. Cold injury can include the usual cane tip dieback, death of dormant buds, and the occasional death of canes and trunks. The temperature required to injure vines varies with the variety, the specific tissue, the time of the season, and the particulars of the low-temperature episode (prior temperatures, cooling rate, low temperature attained, and duration of the cold). It is therefore impossible to state precisely what temperature is required to injure vines. Experience in Virginia has shown, however, that temperatures lower than –10°F will cause at least some vine injury, particularly with varieties of *V. vinifera* (for example, Cabernet Sauvignon or Chardonnay). Even minimum temperatures as warm as –5°F have injured vinifera varieties in some years. The data in Table 4.1 suggest that many sites have been exposed to temperatures less than –10°F. However, those data do not indicate the frequency of the severe cold. A site that experienced a temperature of –10°F every year or two would probably not be economically suited to grape production. If, however, a site experienced temperatures of –10°F only once in every ten years, successful grape production would be more likely. Eastern shore sites experience fewer problems with low winter temperatures because of the moderating influence of the Atlantic Ocean.

Like spring frosts, midwinter low temperatures are significantly affected by the relative and absolute elevation of a vineyard site. Cold air ponds in low areas as readily in the winter as it does in late spring or early fall. It is not surprising, therefore, that many vineyards that chronically suffer spring frost injury also suffer frequent winter injury to vines. Thus, the concepts of air drainage that apply to frost protection also apply to avoiding winter injury.

Winter cold injury can be significant at altitudes greater than 2,000 or 3,000 feet above sea level. A vineyard at such a high elevation is more subject to advective freezes and generally gains little benefit from temperature inversions.

Maximum Summer Temperatures

Maximum rates of photosynthesis in grape leaves occur from 85° to 90°F. Unless the growing season is short, there is little advantage in exposure to higher temperatures. Many locations in Virginia and North Carolina routinely exceed this temperature range on many days during the growing season. High daytime temperatures, coupled with high nighttime temperatures, can reduce fruit pigmentation, aroma, and acidity with certain varieties. Thus, there may be some advantage to locating vineyards where mean summer temperatures are relatively cool. In Virginia, sites having cooler daytime temperatures are generally located at higher elevations (Table 4.1). Air temperature is reduced approximately 3°F for every 1,000-foot increase in altitude. Other factors being equal, a vineyard located 1,500 feet above sea level will have slightly cooler average daytime air temperatures than a vineyard located at 500 feet. There is a limit to the benefit achieved with increased altitude, however. As stated above, vineyards located above 2,000 feet are more subject to low-temperature injury during the winter.

Slope

The *slope* of a site refers to the degree of inclination of the land. A slight to moderate slope can be beneficial because it accelerates cold air drainage. Generally, the steeper the slope, the faster cold air moves downhill, assuming there are no barriers to air movement (Figure 4.2). Steep slopes, however, can create problems. Machinery is difficult if not dangerous to operate on steep slopes, and the potential for soil erosion is increased. Soil erosion is responsible for an average loss of 2 to 8 tons of soil per acre each year in Virginia. Every attempt must be made to minimize that loss. Slopes greater than approximately 15 percent (a 15-foot drop in elevation for each 100-foot horizontal displacement) should be avoided. Consult the local Soil Conservation Service office for advice on erosion control measures.

Aspect

The *aspect* of a slope refers to the compass direction toward which the slope faces (north, south, east, or west). Eastern, northern, and northeastern slopes are probably superior to other aspects. Often, however, other factors such as the presence of woods, steep slopes, and exposed rocks dictate that another aspect must be used. The preference for eastern and northern aspects relates to heat load differences between various slopes. Southern and western exposures are hotter than eastern and northern exposures. Southern exposures warm earlier in the spring and can slightly advance bud break compared to northern slopes. The consequence of advanced bud break is increased potential for frost damage. Southern aspects can also lead to more extensive vine warming on sunny winter days than on northern slopes. The consequences could be reduced cold resistance and subsequent cold injury. Bark splitting and trunk injury to the southwest sides of fruit trees is occasionally observed and is related to trunk warming on sunny winter days with subsequent, rapid cooling. Southern and western aspects can also be expected to be hotter during the summer than northern and eastern aspects. Eastern aspects also have an advantage over western aspects because the eastern slopes are exposed to the sun first. Vines on an eastern slope will dry (from dew or rain) sooner than those on a western slope, potentially reducing disease problems. The basic effects of slope orientation on vine performance are summarized in Table 4.2.

Table 4.2 Relative Effects of Compass Direction of Site (Aspect) on Various Climatological and Vine Developmental (Phenological) Parameters

Climatological or Phenological Parameter	Aspect			
	North	South	East	West
Time of bud break	Retarded	Advanced	Retarded	Advanced
Daily maximum vine temperature	Less	Greater	Less	Greater
Speed of foliage drying in morning	—	—	Rapid	Slow
Radiant heating of fruit in summer	Less	Greater	Less	Greater
Radiant heating of vines in winter	Less	Greater	Less	Greater

Precipitation

Precipitation rates are not generally considered in site selection but greatly affect grape production. The water requirements of grapevines vary with their age, the presence or absence of competition from weeds, and the evaporative conditions to which the vines are exposed. Mature vines can use the equivalent of 24 to 30 inches of rainfall per year. Precipitation records indicate that most Virginia and North Carolina locations average between 40 and 50 inches of precipitation per year. Unfortunately, average records can be misleading because they do not provide a measure of rainfall frequency. Even monthly precipitation averages can be misleading because much of the summer precipitation occurs during thunderstorms. Thunderstorms often affect only a restricted area. Because of their intensity, less of the moisture is absorbed by the soil than when equal amounts of precipitation fall over longer periods. Sites that chronically experience water shortages during the growing season should be avoided, or consideration should be given to supplementing natural precipitation with irrigation.

On the other extreme, the eastern portions of both Virginia and North Carolina often receive higher amounts of rainfall than do the piedmont and mountain regions during the fruit maturation period. Much of that precipitation occurs with tropical depressions and hurricanes that advance up the coast during late summer and early fall.

Soil

The soil supplies vines with most of their essential nutrients and water. Grapevines tolerate a wide range of soil types. Furthermore, vines can be grafted to pest-resistant rootstocks that can extend the margins of soil suitability to some extent. However, the soil must meet certain minimum qualifications. Chief among soil requirements are adequate depth and internal drainage. Potential vineyard sites should have a minimum of 30 to 40 inches of permeable soil. Soils that have a shallow hardpan restrict root development and limit the vines' ability to obtain water during extended dry periods.

Roots also require good aeration. The growth of roots and the welfare of the vine are reduced when soils are waterlogged during the growing season. Well-drained soils are essential for vineyards. The color of the subsoil gives some indication of its internal drainage: well-drained soils generally appear uniformly brown or grade into yellow-orange clay at 15 to 20 inches. The subsoil of poorly drained soils may appear mottled or uniformly gray. Soil drainage can be improved by installing drainage tiles, but the process is expensive. Consult Soil Conservation Service soil survey maps to help determine the suitability of your soil for crop use. County soil survey reports are available through most Cooperative Extension Centers or Soil Conservation Service offices.

Vineyard soils should ideally be of moderate fertility. Experience suggests that very fertile soils can complicate vine management because they promote excessive vegetative growth. Conversely, impoverished soils are liabilities if large quantities of nutrients must be routinely applied to support adequate vine growth. Collect soil samples before planting vines to determine soil pH and macro-nutrient levels. (See chapter 9.) Soil test guidelines are available through county Cooperative Extension Centers.

Despite popular opinion, we are largely ignorant about how different soil types affect wine quality. It seems reasonable to assume, however, that the major effect of soil type is indirect; that is, the effect of soil can be gauged by the impact the soil has on above-ground growth of the vine (for example, excessive versus optimal vegetative growth; balanced nutrition versus nutrient deprivation, or adequate water versus drought).

Proximity to Vineyard Pests

In addition to the physical features of a potential site, the proximity of wildlife and other pests that can pose a threat to grapes should be considered when selecting a site. Chief among those pests are deer and various species of birds. Deer will browse the young, green shoots of the vines and eat the fruit as it matures. Deer are most destructive when vineyards are located close to woods or other deer habitat. If the potential for severe deer depredation exists, some deer protection measures should be used. Commercial chemical repellents, bars of soap, human hair, tankage, and shooting by permit all offer a temporary remedy to deer damage. Experience, however, suggests that electrified deer exclusion fencing is the only means of providing secure, long-term protection of vineyards. Plans for electric deer fences and guides to their use are available from County Cooperative Extension Centers. Also see the references at the end of this chapter.

Birds, particularly flocking species such as starlings, can cause serious crop loss by consuming fruit. Unfortunately, there are no cheap, legal, effective means to combat birds. Sites that are situated near heavy woods in otherwise open country appear to suffer the most damage. Several bird-scaring devices are commercially available, including recorded distress call emitters, propane cannons, Mylar ribbon, and bird-eye scare balloons. Again, experience suggests that those scare tactics offer only temporary crop protection. Bird netting is cumbersome to apply and remove but offers near-perfect exclusion. The overhead netting of entire vineyard blocks is more convenient than is the netting of individual rows.

Sites that are, or were in recent years, wooded or planted to fruit trees should be cleared, cultivated, and planted to a grass sod or cereal grain for one or more years before grapes are established. During that period, rid the site of old roots, rocks, and broad-leaved weeds. Certain broad-leaved weeds and some fruit trees are alternative hosts for nematodes that can also attack grapevines. Nematodes are small, worm-like parasites of which several genera, notably *Xiphinema*, can transmit viruses to grapevines. Soil assays for the presence of these nematodes can be arranged through your local Extension Center. Soils that contain *Xiphinema* species can be fumigated, but the efficacy and economics of fumigation are uncertain and thus not recommended. As an alternative, infested soils should be maintained in a nonhost grass or cereal grain for several years before vines are planted.

Coastal areas of North Carolina and the extreme southeastern part of Virginia are not recommended for bunch grape production because of the occurrence of Pierce's disease. This bacterial disease is transmitted to grapevines by leafhoppers and severely limits grape production in regions where winter temperatures are warmer. The only practical control method is to avoid bunch grape production in regions where the bacteria is endemic. (See chapter 8.) Pierce's disease has also recently been detected in one vineyard on Virginia's eastern shore.

Consideration must be given to existing neighbors when contemplating a commercial vineyard. Equipment such as air-blast pesticide sprayers and bird-scare cannons are noisy and can generate complaints from neighbors. Also consider the possibility of pesticide drift from your vineyard onto neighboring property and vice versa. Pasture owners frequently use 2,4-D herbicides for thistle and other broadleaf weed control. Grapevines are very sensitive to 2,4-D injury. You must inform your neighbors of your intentions to grow grapes and diplomatically request that they avoid using 2,4-D or that they use only low-volatile 2,4-D formulations, preferably before grape bud break.

Summary

The region's diverse topography, its varied climate, and its collection of biological grapevine pests offer commercial grape producers a challenging environment in which to produce quality fruit. The goal of consistently producing high yields of quality fruit will be more easily attained if a good site is selected for the vineyard. Once vines are in the ground, it is prohibitively expensive to relocate them. There are many factors to consider in selecting a site, and focusing on one feature to the exclusion of other considerations is a mistake. Some compromises must invariably be made because few sites offer ideal features in all regards; however, do not compromise on good relative elevation nor on good soil depth and internal drainage.

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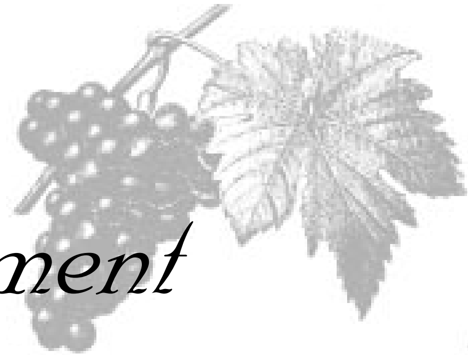
Chapter 5

Vineyard Establishment



Vineyard establishment involves careful planning, thorough site preparation, vineyard design, planting, and trellis construction. Unlike dormant pruning or other annual activities, designing and establishing a vineyard must be done correctly the first time. In addition, the process must be tailored to the particular site and the grower's intentions. This chapter discusses the basic steps in establishing a vineyard and offers suggestions for practical methods and materials. There are many alternatives. Although this chapter may be used as the sole source of information for vineyard establishment, it is advisable to obtain and compare information from additional sources before beginning. References provided here include more detailed information on particular aspects of vineyard establishment, such as trellis construction. It is also helpful to visit existing vineyards to examine their design, compare trellising materials, and discuss plant and row spacing.

Preparing the Site

The first step is to prepare the vineyard site. The main objectives are to correct deficiencies in soil pH and nutrient availability and to prepare a level, clear surface on which to establish the cover crop, vines, and trellises. Some sites are wooded, in which case considerable effort will be needed to prepare for planting. In contrast, cultivated land or well-managed pastures can sometimes be planted to vines with very little preparation.

Soil Testing

Physical soil features should be evaluated in the site selection process. (See chapter 4.) Most important, the soil must meet minimum standards of depth and internal water drainage. Soil survey maps should be consulted to determine the agricultural suitability of any proposed site. The history of crop production at the site can provide some indication of its potential for grape production. Sites that have been cultivated recently are usually in better condition than pasture or abandoned farmland. Heavily wooded sites are the most difficult to bring into grape production, and grape growth often varies across the site because soil has not been mixed by cultivation. Wooded sites may be suited for little else because of their steepness, rockiness, or poor soil.

Detailed soil analyses must be made before a vineyard is established so that pH and fertility can be adjusted if necessary. Procedures for conducting soil tests and interpreting the results are discussed in chapter 9.

Brush and Rock Removal

The vineyard site must be cleared of any trees, brush, and loose rocks before cultivation. The removal of large trees should be followed by subsoiling 18 to 24 inches deep to remove large roots and incorporate lime if applied. It is generally more efficient to hire an experienced bulldozer or loader operator to clear trees and rocks from the site rather than trying to do this task by hand. During site preparation, any impediments to air movement into and out of the vineyard should be removed, which might entail removing adjacent overgrown fencerows or pushing back the edge of shading woods. To avoid shading and root competition, do not plant vines close to adjacent woods or tree lines. As a rule, vines should be planted no closer to shading objects than the average height of these objects. Also enough land should be cleared to erect an electric deer exclusion fence if deer are known to use adjacent cover. The construction of deer fences is a specialized task; see the sources of information listed at the end of chapter 8.

Cultivation

In certain cases, existing pasture can be planted directly to vineyard rows without destroying the groundcover between the rows. This option is feasible if (1) soil tests demonstrate an acceptable pH for the intended grape species and (2) the existing vegetation is suitable as a vineyard cover crop. In this case, the vineyard rows are marked off (see "Marking Off the Vineyard") and a 24-inch sod strip in the row is killed with a postemergence herbicide, usually in the fall before planting. To foster root development, rows can be ripped with a 18- to 24-inch single-shank ripper before planting.

More frequently, the need for soil pH and nutrient adjustment or perennial weed eradication will require soil cultivation. Various schedules can be used in establishing a vineyard. One logical sequence for preparing and planting a partially wooded site is as follows:

Late winter: Complete the tree, brush, root, and rock removal process.

First spring: Adjust soil pH and fertility; plow and disk the site; plant a cereal crop such as spring wheat or oats.

Summer: Spot treat residual perennial weeds with herbicides.

Late summer: Apply additional lime if necessary; plow in the cover crop residue; plant a perennial cover crop.

Second spring: Apply a postemergence herbicide to vine rows; auger holes and plant the vines.

Summer: Set posts and construct trellises.

Regardless of the time frame or approach followed, it is important to rid the site of persistent weeds, brambles, brushy trees, and other unwanted vegetation before setting vines. In some cases, weed eradication might require the planting and cultivation of cover crops for a period of two years rather than one as outlined above. Chisel plowing to a depth of 12 to 24 inches helps to incorporate lime and loosens compacted soil. It may be possible to reduce costs by employing the services of a local custom equipment operator. Operations such as plowing and disking may be needed only during the establishment phase and thus it may not be necessary to purchase specialized equipment.

In most Virginia and North Carolina vineyards, perennial cover crops are planted between the rows. A perennial cover crop, as the name implies, is one that is retained from year to year. Grasses are preferred because they do not serve as alternative hosts for nematodes and because grass retains its foliage during the winter, reducing soil erosion. Nematodes are tiny worms that can damage vines by their feeding or by trans-mitting virus diseases. If the intended vineyard site has been used for grape or other fruit production within the last five years, the soil should be tested before planting to determine nematode populations. Instructions for nematode assays are available from County Cooperative Extension Centers.

Cover crops offer several important advantages over clean cultivation (leaving the soil bare).

Soil erosion control: On average, Virginia's cultivated agricultural acreage loses about 8 tons of soil per acre per year. Similar losses occur in North Carolina. This loss is greater on hilly terrain where vineyards are often located. Grass sod reduces erosion by lessening the impact of rain and slowing the movement of surface water, thus allowing greater water infiltration.

Increased vineyard accessibility: A permanent cover crop makes it possible to enter the vineyard with equipment sooner after a rain than if the soil is bare. The sod increases the rate of soil moisture loss and provides greater traction for machinery.

Moderation of vine vigor: Cover crops can reduce vine growth rates, which can be either an asset or a liability, depending on available moisture, vine size, and vine vigor. Grapevines grown in our region — particularly grafted vines —often produce more leaf area than the trellis and training system can expose to sunlight. This situation is referred to as high vigor. The excess growth can lead to an undesirable degree of canopy shading, reducing fruit quality. Competition for water and nutrients by cover crops can reduce the vegetative growth of vines, thereby reducing canopy shading problems. Unfortunately, cover crops can adversely affect weak vines, particularly during droughts. Mowing and maintaining a 24- to 36-inch clear area under the trellis can minimize competition between the cover crop and the vines.

Several grass species are acceptable as vineyard cover crops. Kentucky-31 (*Festuca arundinacea*), a tall fescue variety, has been used extensively in Virginia vineyards. Like many grasses, Kentucky-31 grows most vigorously during the cool, wet periods of spring and fall. Fescue can be sown at rates of 50 to 75 pounds per acre; heavier rates reduce “clumping” and result in more uniform turf. Other tall fescue varieties include Bonanza, Apache, Olympic, Rebel, and Jaguar. These other fescues might also be acceptable, but vineyard trials have not been conducted in Virginia. Other grasses used as cover crops include Kentucky bluegrass, orchardgrass, creeping red fescue, and various blends of dwarf fescues, such as those used in home lawns. Most grasses will establish better if sown between mid-August and mid-September rather than during the spring. Most seed distributors can provide specific recommendations on seeding methods. Nitrogen fertilizer can be broadcast at 35 pounds of actual nitrogen per acre at the time grass is sown to stimulate growth.

If an existing vineyard is to be replanted, the old vineyard should be cleared and planted to grass or cereals (for example, oats or barley) for a minimum of two years. This fallow period will help reduce populations of grape root pests, perennial weeds, and concentrations of preemergence herbicides that might be present.

Designing the Vineyard

If all vineyard sites were level, clear parcels of land and had ideal soil conditions, vineyard establishment would be relatively straightforward. It would be necessary only to mark the rows (posts and vine locations) using suitable spacings, and then dig holes and plant the vines. Not all vineyard sites, of course, are equal. Proposed sites are commonly on slopes; sometimes they are partially or completely wooded and others are characterized by irregular knolls and depressions.

Vineyard design starts with evaluating how the vineyard will conform to existing topographic features and property boundaries. Vineyard planning should achieve these primary goals:

- ❑ prevent soil erosion (intentionally ranked highest in priority)
- ❑ use land area efficiently
- ❑ optimize vine performance
- ❑ facilitate vine management and equipment operation.

Partitioning the Vineyard into Blocks

Vineyards larger than several acres are generally partitioned into "blocks." A block might represent a single variety or, on uneven terrain, blocks might reflect the allowable planting area. Division of a large vineyard into blocks is also convenient for keeping records of inputs (such as pesticides and labor) and returns (fruit yields) for cost-accounting purposes. Figure 5.1A illustrates a vineyard partitioned into several blocks. The blocking pattern used was intended to keep most rows running perpendicular to the existing slopes. Dividing a vineyard into blocks might also be necessary because of existing fence lines, roads, or natural features such as streams or rock outcroppings. In designing the vineyard, reserve the highest locations of the site for varieties that are sensitive to winter cold and for those that break bud early in the spring (Figure 5.1B). Initial vineyard design should include sketches of the property with plantable areas drawn in or superimposed on clear plastic overlays.

Row Orientation

On level sites, rows should be oriented to maximize length and minimize number. Such an orientation minimizes the number of expensive end-post assemblies. Most sites are not level, though. Rows should be oriented across, or perpendicular to, the predominant slope of the site to minimize soil erosion. Do not contour or curve rows around hills; the trellises of curved rows are structurally weak. In cases where the site is hilly, it is sometimes best to position the rows in a herringbone pattern. Low areas and gullies should be left open and sodded to serve as erosion barriers or traffic alleys. Some advantage can be gained by orienting rows parallel to prevailing summer breezes to aid vineyard ventilation. A further consideration is to maximize sunlight interception by the vine canopies. Field research and computer simulation studies have shown that rows oriented in a north-south direction receive more sunlight and produce slightly higher yields than those oriented east to west. Thus, if other factors are equal, it is desirable to align rows as closely as possible to a north-south axis. Generally, however, orientating the rows to minimize soil erosion should take precedence over other considerations.

Row Spacing

Maximum vineyard productivity is attained when most of the available sunlight is intercepted by grapevine leaves. Sunlight striking the ground can be thought of as wasted energy. Research shows that vineyard productivity and grape quality are maximized when grapes are grown in rows with their foliage trained to thin, vertical canopies. Row spacing in such a design (the distance between two adjacent rows) should be no less than the intended canopy height to minimize row-to-row shading of adjacent canopies.
Most trellises are constructed with 8-foot line posts set 2 feet into the ground, thus providing a 6-foot-high trellis supporting about 4 feet of canopy. Thus, for conventional nondivided canopy training systems, the row spacing should be no less than 4 feet. Conventional vineyard equipment widths, however, usually limit the minimal row spacing to 8 to 10 feet. Equipment availability and operation should be considered carefully before deciding on row spacing. A relatively wide spacing (10 to 12 feet) is advised on steeper terrain (5 to 15 percent slope) or where horizontally divided canopy training systems are planned. (See "Trellis Construction.")

Vine Spacing

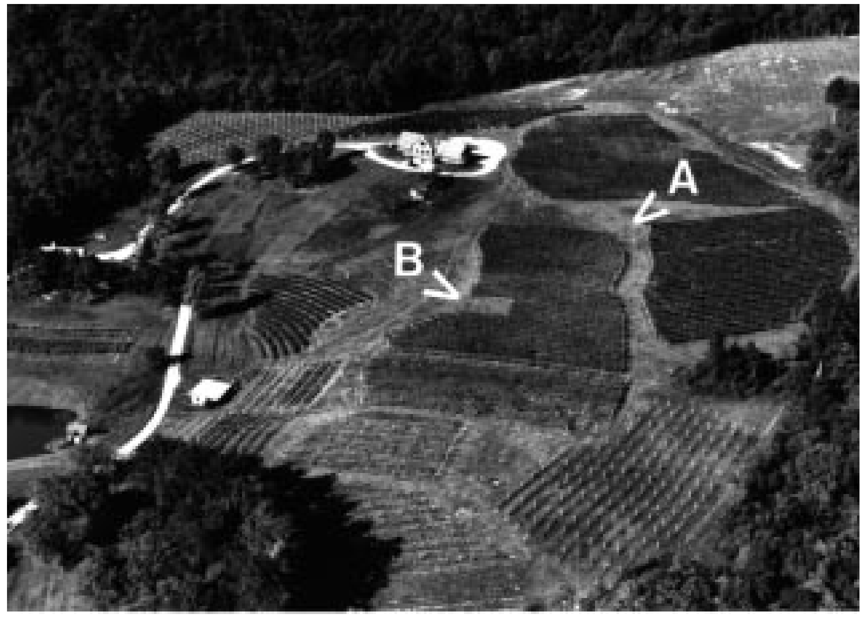
Perhaps no other aspect of vineyard design leads to as much difference of opinion as vine spacing: the distance between adjacent vines along the same row. Vine spacing ranges from 3 to 12 feet in Virginia vineyards, with 6 to 8 feet being most common. From an economic standpoint, close vine spacing (less than 4 feet) increases the yield per acre in the initial years of production. However, that accelerated return can be offset by higher costs for materials (vines and training stakes) and labor (planting and training). There is no evidence that close spacing improves vineyard yields or fruit quality, and there is ample evidence that it complicates canopy management. On the other extreme, wide vine spacing (greater than 10 feet) can result in poor trellis fill (the amount of trellis occupied by foliage), particularly with cane-pruned vines or after winter injury to trunks and cordons. Therefore, a planting distance of 6 to 10 feet between vines is generally recommended for nondivided canopy training systems. A 6-foot spacing is recommended for low vigor situations (such as nongrafted vines grown in poorer soils). The 10-foot spacing is recommended for grafted vines in rich soils or where irrigation is used.

Headlands and Alleys

Ample room should be left at the end of vineyard rows (the *headland*) to provide space to turn equipment. Tractors with attached trailer-type air-blast sprayers require a minimum of 30 feet turning clearance (Figure 5.1a). Rows longer than 600 feet should be divided at the midpoint with a cross alley to facilitate movement of machinery and personnel.

Marking Off the Vineyard

Before vines are planted it is necessary to mark vine and post locations to ensure uniformly spaced vines and parallel rows. In the two methods described here, the vines are planted first in preaugered holes, followed soon afterward by pounding of posts and construction of trellises. Obviously, it is possible to reverse that order and pound or set posts before the vines are planted. In either case, it is extremely important to mark off straight and parallel rows. Figures 5.2a through 5.2c illustrate the basic steps involved in marking off an irregularly shaped vineyard block of about 4 acres.



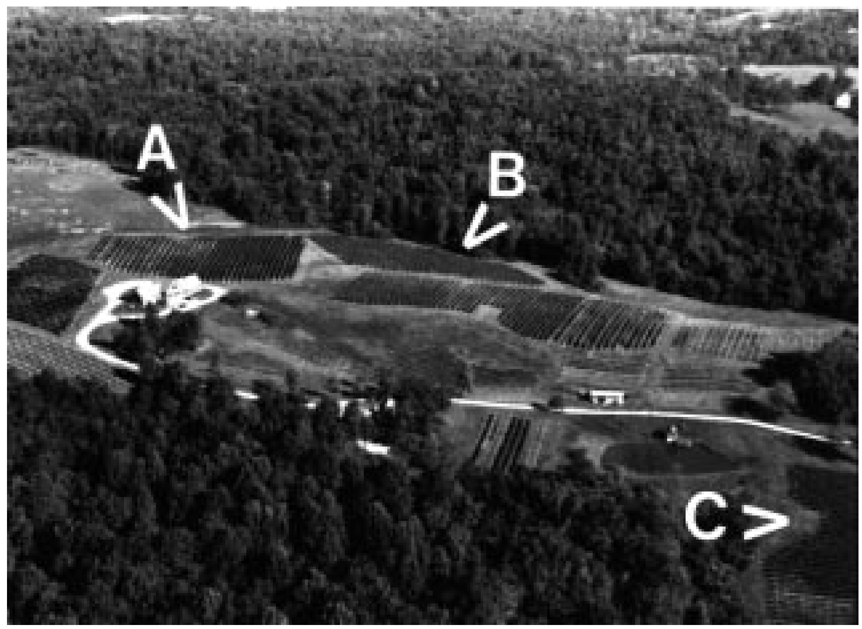
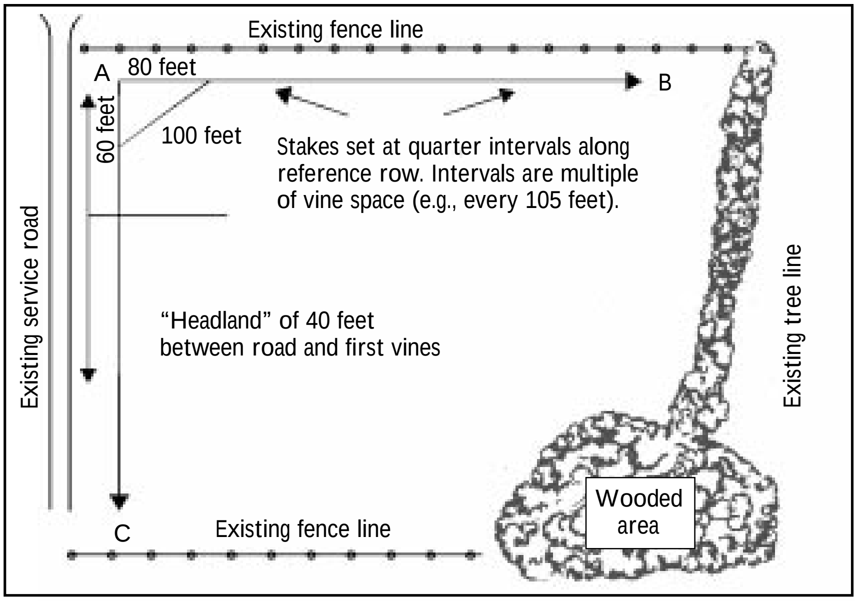
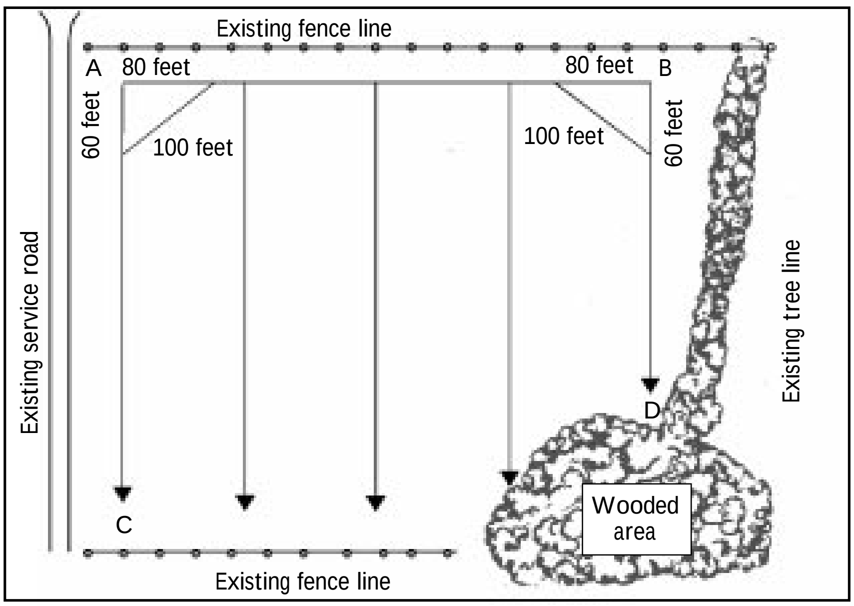


Figure 5.1a (top). The blocking pattern of this vineyard was designed to keep most rows running perpendicular to the prevailing slope. (A) Unplanted alley separates two blocks that have different row directions. (B) Inset area was considered too steep to plant.

Figure 5.1b (bottom). Varietal differences in time of bud break and cold hardiness were used to determine the relative elevation of vineyard blocks. The difference in elevation between highest (A) and lowest (C) blocks is approximately 100 feet. (A) Chardonnay: cold tender, early bud break. (B) Vidal blanc: cold hardy, late bud break. (C) Seyval: cold hardy, early bud break, good secondary crop potential.

The first step in marking the block is to choose a reference point—one corner of the vineyard block and one end of a reference row





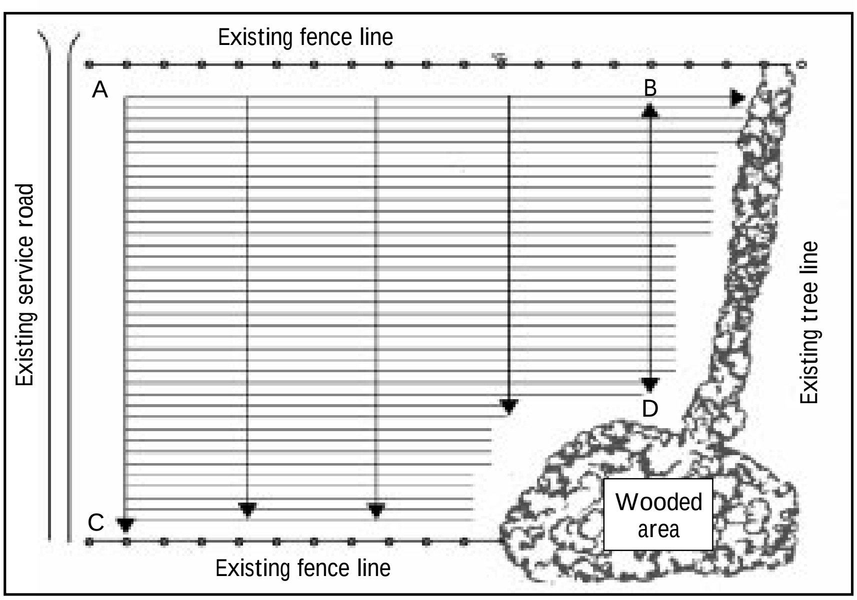


Figure 5.2a (top). Marking off vineyard: The reference point (A) is chosen to establish the first right angle corner of the vineyard.

Figure 5.2b (center). The second corner (B) of the vineyard is established. Grid lines are staked to further ensure that vineyard rows will be parallel.

Figure 5.2c (bottom). Vine locations are marked in each row by stretching a pre-marked wire between corresponding row ends.

(point A in Figure 5.2a). The reference row is typically the first row in a block, but it can be any row. The reference point or corner is used to establish a grid upon which the vines and posts will be set. The reference point is also the location of the first vine of the first row. Therefore, leave an ample headland plus one-half a vine space behind the reference point to set an end post. The reference row is typically set parallel to an existing property boundary, fence line, ridgeline, or roadway. In Figure 5.2a, the reference row is set parallel to an existing fence line. On level land, the reference row can be oriented more arbitrarily or to a preferred compass direction (for example, north-south).

With a reference point chosen, the next step is to mark off a precise right angle. One leg of this angle is the reference row and the other leg defines the first vines in each of the following rows. It is critical that this first corner of the vineyard be a true right angle to achieve a square or rectangular pattern to the vineyard rows. A surveyor's transit is useful for establishing right angles and straight rows. Position and level the transit over the corner reference stake (point A in Figure 5.2a). Aim the transit down the intended length of row 1. The point of aim could be another stake (B in Figure 5.2a) set to form a line parallel to an existing landmark (that is, the fence line), or the line could be arbitrary. Set the transit dial compass (if equipped) to 0°. Sighting through the transit, have an assistant with a range rod set stakes (use 18-inch surveyor's stakes) at quarter intervals down the length of row 1. The stake intervals should be some multiple of the vine space distance. In Figure 5.2a, the stakes were set every 105 feet

(7 x 15). Be sure that the tape measure used to determine these intervals is pulled taut and that it is held close to the ground.

Having marked the reference row, turn the transit 90º and sight down the row ends to point C (Figure 5.2a). Have an assistant with a tape measure set stakes at intervals corresponding to end-post locations (for example, every 10 feet). At this point, check the trueness of this first corner of the vineyard. This can be done by ensuring that the dimensions of the corner correspond to the 3:4:5 ratio of the sides of an accurate right triangle. Place a stake in the reference row 80 feet (4 x 20) from the corner stake (point "A"). Place another stake 60 feet (3 x 20) (the sixth row if using 10-foot rows) in the line of row-ends. The diagonal line between these two stakes will be 100 feet (5 x 20) if a true right angle has been established (Figure 5.2a).

Move the transit to the opposite end of row 1 (point B) and level it. Rezero the transit by sighting back down row 1. Turn the transit 90º and sight across the rows (point D in Figure 5.2b). Note that in Figure 5.2b the north end of vineyard rows is staggered to maintain a 30- to 40-foot headland between the row ends and the tree line. Point B was chosen as a reference point common to all rows above the wooded area. Have an assistant with a tape measure mark row widths as before. Repeat the process of ensuring that this second corner is a true right angle. Repeat the cross-row staking at the quarter-interval stakes along row 1. Check the distance between these grid lines at both ends to ensure that they are parallel and their corners are true right angles. The quarter-interval grids need not be marked off in small plantings.

Once vineyard row widths have been established, mark all vine locations in all rows, starting with row 1 (Figure 5.2c). Use a length of trellis wire long enough to extend the length of the longest row. Mark the wire at intervals corresponding to vine spacing with white paint or adhesive tape (for example, every 7 feet). Stretch the wire tautly between the row end markers of row 1 and mark each vine location (Figure 5.2c). The wire should be kept close to the ground when traversing depressions in topography. A good steel tape measure can be used in lieu of premarked trellis wire. Vine locations can be marked by dropping 1/4 cup of lime at the desired spots or by spraying a spot of white paint on the ground.

Repeat the above process to mark vine locations in all remaining rows. Remember to leave one-half a vine space behind the first and last vine of each row to later place the end posts. Post locations can be determined in a similar fashion either before or after vines have been planted.

Planting

Vines are usually planted in the spring, generally between the first of April and the end of May. It is not necessary to delay planting until after the threat of spring frosts. Fall planting is also permissible if arrangements can be made to receive vines from the nursery during that period. Be sure that vines planted in the fall were recently dug and are in a dormant condition. Vines that have been in cold storage over the summer are apt to commence growth if planted in the fall and subsequently exposed to unseasonably warm weather. In that event, the vines would be susceptible to severe winter injury. It is also desirable to hill up soil around fall-planted vines to reduce heaving that can occur with repeated freezing and thawing of loosened soil.

Nursery Stock

The number of vines to order depends upon row and vine spacing. For small plantings, divide the row length by the vine spacing, round up to a whole number if necessary, and multiply by the number of rows. For larger plantings, first determine the area of the vineyard (multiply the length by the width) and divide that figure by the area occupied by a single vine (the row spacing multiplied by the vine spacing). Add 1 percent extra vines to allow for poor vines or loss during the first year. The extra vines can be planted closely in a nursery and used later as needed.

Vines should be purchased only from reputable nurseries that offer certified disease-free stock. Nurseries that specialize in grapes generally offer better prices and quality than nurseries that sell a variety of plant species. Vines should be ordered well before the intended planting date. For spring planting, order vines no later than October or November of the previous year. In some cases—for example, if a particular rootstock is desired—it might be necessary to order vines one to two years before planting. For unusual varieties, it may be preferable to order the budwood from a certified source, such as the Foundation Plant Materials Service (FPMS) at Davis, California (see the appendix), and have the budwood delivered to a reputable grafter or nurseryman for grafting or rooting.

Receiving Stock

Arrange to have stock delivered several days to a week before the intended planting date. Remember, there is no guarantee that planting conditions will be suitable at the time the vines are delivered. For that reason, provisions should be made to hold the vines in a cool, shady place upon delivery. Upon receiving stock, open the shipping containers and ensure that the roots are moist. Keep the vines cool and roots moist until planting time. It is critical that the roots of unplanted vines not be exposed to freezing temperatures. The vines should arrive in a dormant condition and, depending on temperature, should not break bud for one to three weeks.

Setting Vines

Holes for vines should be augered as an independent operation before the day of planting. Auger holes using a 9- to 12-inch-diameter auger. The holes should be about 12 to 18 inches deep. Holes augered in heavy clay soils often have glazed, impermeable sides, particularly if the soil was wet when drilled. The smooth surfaces of glazed holes can restrict root growth. The sides of auger holes should therefore be scored with a hoe or hand trowel before planting. The soil should be moist on the day of planting. Wet soil is apt to compact; dry soil can desiccate tender roots.

The roots of the young vines should not be trimmed; however, trimming the roots is better than twisting the roots to fit the hole. (The ideal way to accommodate large roots is to drill a larger hole.) The vine roots must be kept wet during planting. Even brief periods of drying can injure the roots. A convenient method of keeping roots wet while carrying vines in the field is to place 10 to 20 vines in a 5-gallon plastic pail half filled with water. Grafted grapevines should be set in the hole with the graft union several inches above the soil level (Figure 5.3). Soil settling should result in the graft union being an inch or so above the soil line. If set too deep, the scion, or fruiting, portion of grafted vines will develop roots that will be difficult to remove. Such vines can become susceptible to phylloxera attack. Nongrafted grapevines should be set with the crown (junction of older wood and newer canes) 1 or 2 inches above the soil line (Figure 5.3). Spread the roots in the hole and backfill with soil. Firm the soil but do not pack it. Water the vines thoroughly as soon as possible after planting. In this regard, a preestablished irrigation system offers a decided advantage.

Mechanical Planting

Planting by hand, as outlined above, is suitable for small (1- to 10-acre) plantings. For larger plantings, the speed of mechanical planting makes it more attractive. Mechanical tree planters can be rented for this purpose.

Initial Vine Training

Vines should be pruned back after the last threat of spring frost to a single cane of two to three buds. At that time it is desirable to place a 4- to 5-foot stake at each vine (Figure 5.3). Bamboo stakes are available for this purpose and are relatively inexpensive. Stakes serve two purposes: they clearly mark vine locations and they serve as a support to which developing shoots can be tied. The stakes should be set 10 to 12 inches deep and should be long enough to be tied to the first wire of the trellis system. First-year vine training is similar regardless of the intended training system. Training systems are discussed in chapter 6.

Constructing the Trellis

Research and experience have led to specialized methods and materials for trellis construction, many of which are adapted from modern fence-building concepts. Some excellent information is commercially available on this subject. (See the sources listed at the end of this chapter.) The vineyard trellis must be strong enough to support large crops as well as to bear the force of occasional high winds. Consider that the trellis will represent a major investment and should serve for 20 or more years with routine maintenance. The following discussion pertains to the construction of a typical nondivided canopy training system with three to seven wires.

Posts

Pressure-preservative-treated yellow pine or other softwood posts are the most commonly used and recommended for vineyards in this region. Eight-foot posts are standard; when set 2 feet deep, they provide a 6 foot-high trellis. Longer posts are desirable only for deeper placement, as with end posts or brace assemblies. Round posts are preferred to square-cut posts; round posts have much greater shear strength than square-cut posts of comparable size.

Chromated copper arsenate (CCA), which imparts a greenish tint to the wood, is currently one of the most common wood preservatives.

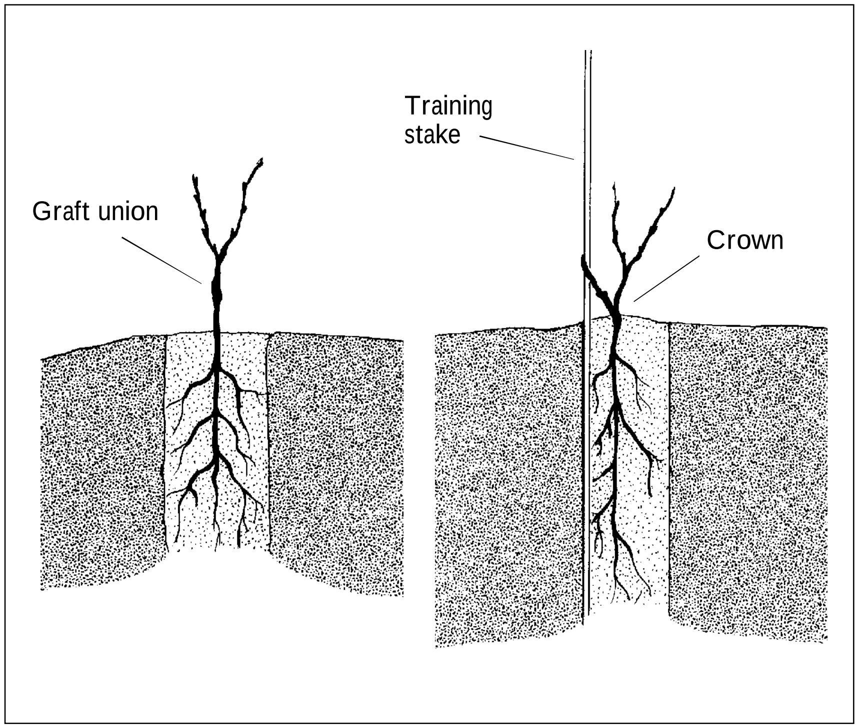


Figure 5.3 Correct planting depth for grafted (left) and nongrafted (right) grapevines.

Because the preservative is toxic, workers should wear gloves and protective eye wear when handling or cutting new posts, and CCA-treated wood should not be burned. The pressure-treating process results in a post with a lifespan 10 to 15 years greater than that of a post simply dipped in the same preservative. It is inadvisable to use untreated posts in the vineyard. Locust or cedar posts, debarked and painted with a wood preservative on the ground-contact portion, can be used; however, the labor required to prepare these posts usually makes commercial posts more attractive.

Line posts (as opposed to row-end posts) should be at least 3 inches in diameter at their smaller end. End posts should be at least 5 inches in diameter and are often 1 or 2 feet longer than line posts so that they can be set deeper. Posts can be set in either of two ways: they can be driven with a post pounder or they can be set in augered holes and backfilled. Driving posts is much faster; by one estimate, two people can drive six posts in the time required to auger a hole and set one post. Furthermore, because the driving disturbs less soil, the driven post is more

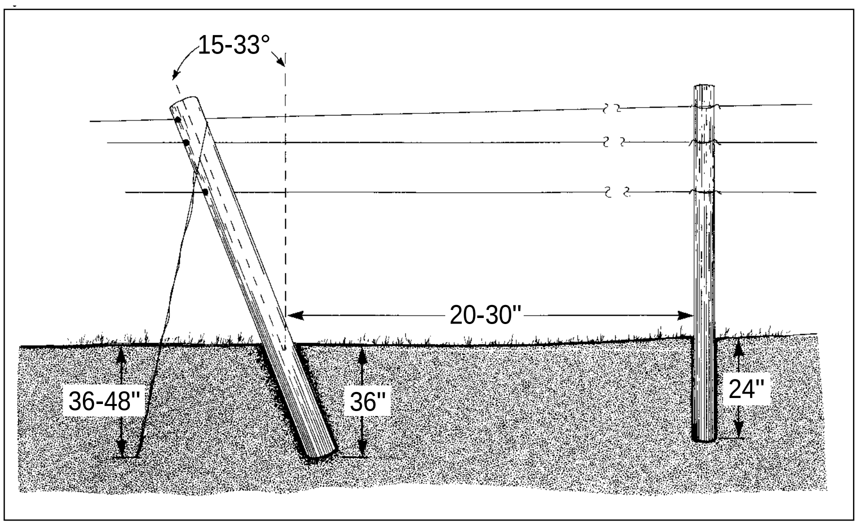
Figure 5.4 (top). External end-post brace assembly suitable for non-divided canopy trellises with row lengths less than 600 feet.

Figure 5.5 (bottom). External end-post brace assembly used for divided canopy trellises and rows greater than 600 feet.

stable than a post set in an augered hole. Most posts have a slight taper. The smaller end should be driven into the ground. In heavy or stony soils, it might be necessary to saw a bevel on the end of the post to facilitate driving. Driving is also easier if the soil is moist. If posts are to be set in augered holes, the end of the post set in the ground is less important.

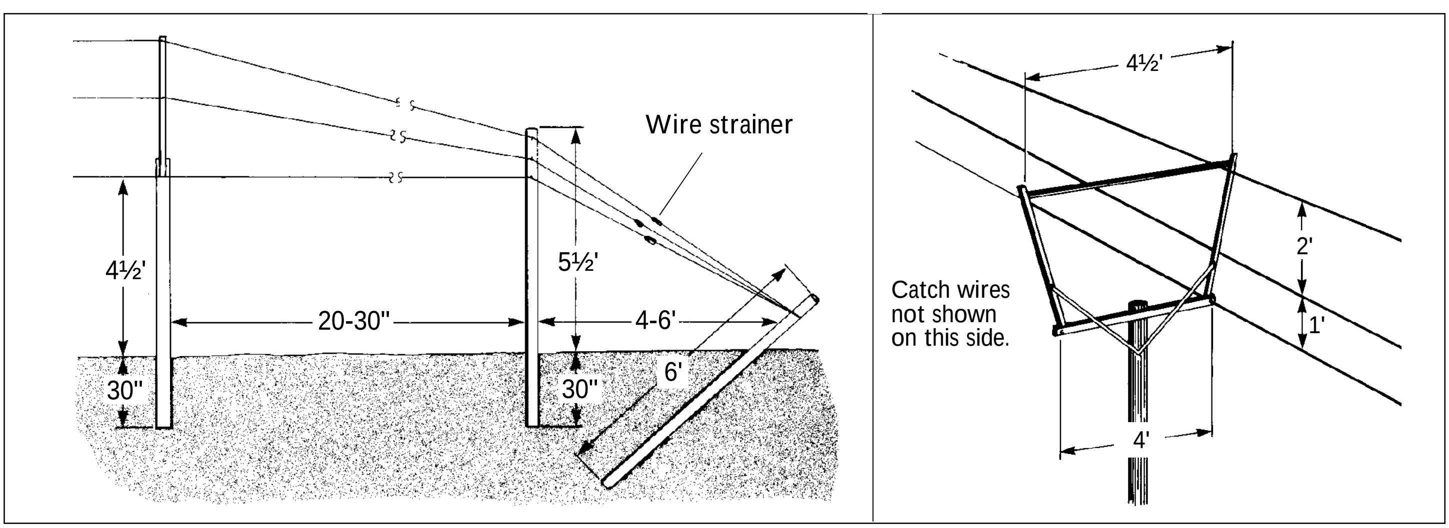
Wire

Many different types of wire have been used in grape trellises. Before about 1970, the most commonly used type was soft, galvanized 11- or 12-gauge wire. More recently, high-tensile (HT) galvanized steel wire has been preferred because of its greater strength and longevity. The HT wire should have class III galvanizing and possess a breaking strength of at least 170,000 pounds per square inch. Wire gauges of 11 to 12.5 are acceptable; 12.5 is the most common. HT wire, which can be stretched to 250 pounds of tension, is preferable to softer wire. At that tension, expansion and contraction with changes in temperature is minimized, reducing time spent in tightening loose trellis wires. The greater tension that can be applied to HT wire also permits a relatively wide post spacing (20 to 30 feet) without wire sagging. HT wire is hard and coiled under tension. Wear gloves, appropriate clothing, and eye protection when handling it. Hold the wire ends firmly when pulling, and stick loose ends into the ground until fastened to the trellis to prevent recoiling.



Brace Assemblies

Strong row-end braces are critical to the strength of a trellis. A common means of bracing the row end is an external brace, as shown in Figure 5.4. The external or tie-back brace is generally suitable for nondivided canopy trellises with row lengths up to 600 feet. The end post should be at least 5 inches in diameter and 9 feet long and should be set or driven 3 feet into the soil at 15 to 30° off vertical (away from the row). The post is then anchored with a “deadman.”

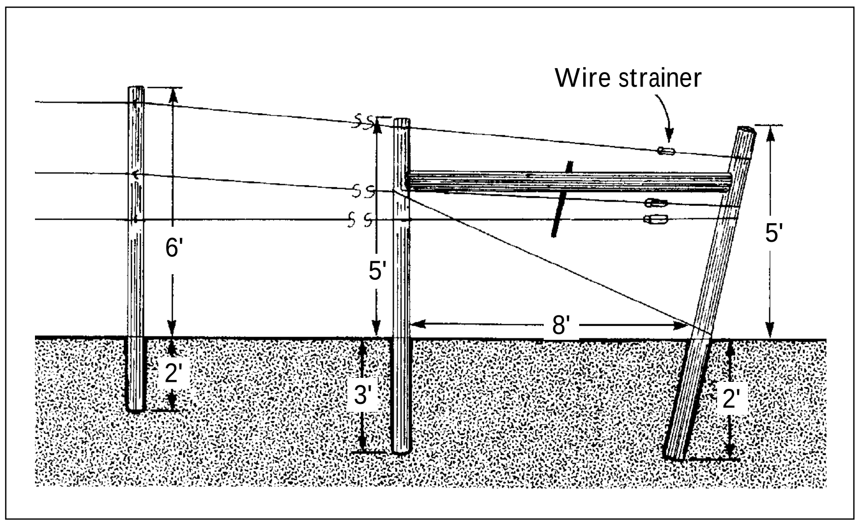


Steel screw-type anchors (for example, 4- to 6-inch screw on a 5/8-inch by 48-inch galvanized shaft) are commonly used. The deadman anchor is braced to the end post with a double loop of 9-gauge bracing wire. Bracing wire is soft and can be twisted without breaking. A "twitch stick" placed in the loop and turned will take up the slack in the brace wire. Be sure to twist the brace wire in the same direction that was used to screw the anchor into the ground (clockwise). A variation of the external brace uses an 8-foot post driven 6 feet into the ground rather than a steel anchor (Figure 5.5). This stronger anchoring is recommended for divided canopy training systems to support the weight of heavier crops. One disadvantage of external bracing is the exposed brace wire or wires which can be hit by tractor tires or trip the unwary worker. An internal brace assembly (Figure 5.6) avoids this problem and is stronger than a steel-anchored brace. The internal brace is more expensive, however, because several posts are required for each assembly.

Construction

It is generally most efficient to construct the trellis in steps over the entire vineyard rather than completing the trellis row by row. The trellis posts, row-end braces, and at least one wire should be installed during the first growing season. Install end posts or end brace assemblies first. Then mark the line post locations (as was done earlier with vine locations) by stretching a premarked wire between the corresponding end posts of a given row and marking each post location with a stake, lime, or paint. The post spacing was determined when the vine spacing was measured. Use a multiple of the vine spacing distance for post intervals, but do not exceed 30 feet (20 to 30 feet is common). Remember that the first and last vines of a row are only one-half a vine space from their respective end posts. With post locations marked, drive posts by working across the rows. As an alternative, rows can be straddled with the tractor and posts pounded by row if the staking of vines is delayed until the posts are set. Use a builder's level to plumb the postdriver to ensure that each post is driven vertically.

Wires are strung and stapled after the posts have been installed. At least one wire, usually the lowest, should be strung in the first season to facilitate vine training. The wire heights can be marked on the post by using a notched or marked template with the desired wire locations. The number of wires and their locations varies with the intended training system. (See chapter 6.) Use a wire jenny or spool to dispense the coiled wire and prevent tangles.



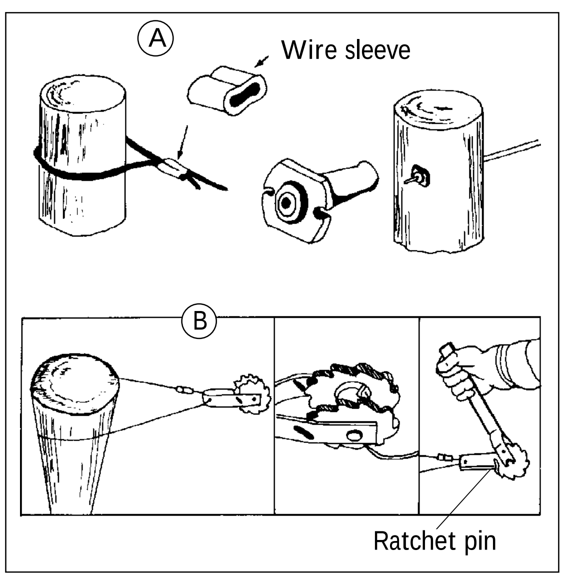


Figure 5.6 (above). Internal end-post brace assembly.

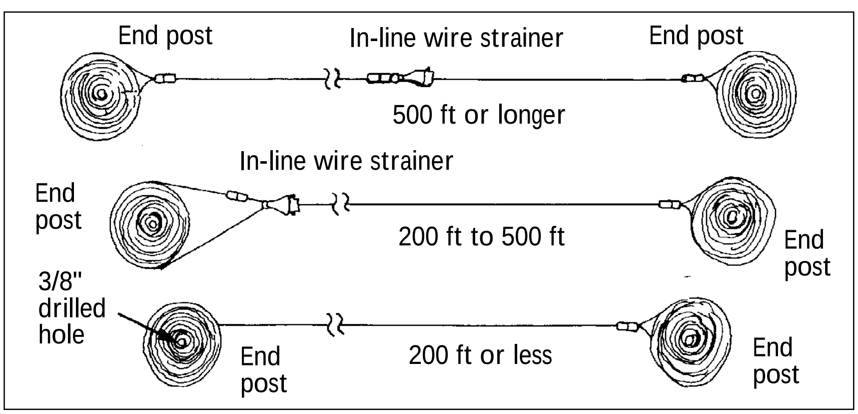
Figure 5.7 (left). Methods of fastening wire: compressible wire sleeves and "wire vise" (A) and in-line wire strainer (B).

Position the jenny at one end of the row and pull the loose end of the wire to the opposite end of the row on the windward side of the row to which it will be stapled. Attach the loose end of wire to the end post with two compressible wire sleeves (Figure 5.7) at the appropriate height. Cut the opposite end from the coil and attach it to the corresponding end post by one of three methods, depending on row length (Figure 5.8). The wire can be fitted with an in-line strainer, inserted in a wire vise, or tied off with wire sleeves (Figure 5.8). In the last case (for row lengths greater than 500 feet), an in-line strainer is mounted at the midpoint of the row. Do not completely take up the slack wire until the wire has been stapled to all posts. Wire vises are recommended only for rows less than 200 feet long and for foliage catch wires. In-line strainers should be used for cordon support wires in rows 200 to 500 feet long. For rows greater than 500 feet in length, splice in-line strainers in the middle of the row to tension the wire effectively over its entire length. Wires can be extended beyond the end post and tied to earth anchors (Figure 5.5).

For paired catch wires, pull the wire around the opposite end post and draw it back to the starting point to form a continuous loop. Secure the loop at the far end of the row with a loose staple. With this method, wire vises or another type of tensioner is needed only at one end of the row.

Wires should be stapled loosely to the line posts so that they can move freely through the staples. Hold the wire against the post with the body while using both hands to hold and drive the staple. Avoid denting or crimping the wire during stapling. Some prefer to place staples in the posts before stringing the wire. In this case, the wire is threaded through the staples as it is dispensed. Wires are tensioned after stapling is completed. If multiple wires are installed, tension the highest wire of the trellis first, followed by successively lower wires.

Figure 5.8 Three methods of fastening and tensioning trellis wire.



Divided Canopy Training

Grapevine canopies represent the three-dimensional arrangement of foliage on the grape trellis. Canopy division is a method of exposing more of the vine's foliage to sunlight and can be a beneficial means of improving yields and fruit quality with large vines. Canopy division is cost effective only if the vines are expected to be large and if the principles for management of divided canopy training are understood and recommended practices are followed.

Two divided canopy systems that have gained some use in Virginia and that could be used in North Carolina are the Geneva Double Curtain (GDC) and the open U, or *lyre*, system. Both systems are described in chapter 6. Specialized materials are available for these systems, which will probably be cost effective considering that less labor is required for construction and their longevity is greater. Row spacing should be increased to 12 feet with either of these divided canopy systems unless narrow vineyard equipment is used. More sophisticated end brace assemblies are recommended for divided canopy systems to support the greater crop loads possible with those systems (Figures 5.5 or 5.6).

Summary

This chapter has presented practical techniques and materials for vineyard establishment. These techniques and materials may be further refined, and other alternatives are available. Prospective growers should visit existing vineyards and review vineyard design and construction techniques. Some questions to address in those visits are:

- ❑ Is there evidence of soil erosion resulting from row orientation?
- ❑ Is land efficiently used?
- ❑ Does the vineyard design facilitate equipment and personnel movement?
- ❑ Are row end brace assemblies secure?
- ❑ Are trellis components in good repair?

Most established growers can comment on at least one or two items that they would do differently if they were to re-establish their vineyards. Once vines and posts are in the ground, it is difficult to correct design flaws.

Publications on Trellis Construction

- ❑ *How to Build Orchard and Vineyard Trellises*
  Available from:
  Kiwi Fence Systems, Inc.
  RD 2 Box 51-A
  Waynesburg, PA 15370
- ❑ *Directory of Vineyard and Winery Products* (suppliers)
  Available from:
  Vineyard and Winery Management
  103 Third St., P.O. Box 231
  Watkins Glen, NY 14891
- ❑ *Sunlight into Wine*
  Available from:
  Practical Winery and Vineyard Magazine
  15 Grande Paseo
  San Rafael, CA 94903
- ❑ *Oregon Winegrape Grower's Guide*
  Available from:
  Practical Winery and Vineyard Magazine
  15 Grande Paseo
  San Rafael, CA 94903