

A Practical Guide to Developing a Commercial Wine Vineyard



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Foreword



I was flattered by Mark Chien's invitation to write the foreword for his book. When I received his invitation I had just finished reviewing *The Wine Grape Production Guide for Eastern North America* (2008) edited by Doctor Tony Wolf of Virginia Tech. In that review I stated how well served the Eastern States of the USA were in their viticulture endeavors by that book. And now, hot on the heels is Mark Chien's *Practical Guide to Developing a Commercial Wine Vineyard*. The grape growers of Eastern USA are doubly blessed.

As Mark says his book should be seen as a compliment to that mentioned above. And I believe it is. Mark has written a very down-to-earth and practical book which should be on the bookshelf, and more importantly in the mind, of anyone planning a vineyard investment in the Eastern USA.

I have worked with Mark on several occasions and always enjoyed his commitment to his growers and to the Pennsylvania wine sector. He is a charming person, and very dedicated. His frank and forward style of speaking about viticulture is evident in this book, I can almost hear him speaking as I read it.

The scope of the book is excellent for beginners in viticulture. There are 21 chapters covering the technology and psychology and sociology of vineyard development. I like Mark's emphasis on continuing education. A grower who is not always trying to learn is not prepared to make his or her vineyard as good as it can be.

Mark's book covers the most important aspects of vineyard development from a reality check about why you want to do it, the harsh truths of vineyard economics, the great importance of site selection (I tell my audience this is more important than spouse selection!) Almost as important is what to plant, and how you will trellis and manage your vineyard.

This book is not written as an academic text. Mark is flooded with enquiries from people perhaps just like yourself who are tempted to set out in the business of grape growing in the Eastern USA. You share those aspirations with Thomas Jefferson, but are more likely to succeed because we know now so much more about it than when Jefferson made his first attempts. The eastern USA is not an easy place to grow wine grapes but the rewards in terms of wine quality can be substantial. And, add to that, you live among one of the most important and affluent wine markets in the world.

I hope Mark's book is a bestseller. It deserves to be, and for those new growers contemplating this significant step in their lives, you are in good hands using the principles contained in this book.

Good luck to you, and thanks to Mark for making it that much easier.

Dr. Richard Smart
Smart Viticulture, Tasmania, Australia

Preface

I once talked to Lucie Morton, a well-respected, French-trained viticulture consultant in Virginia, about a very high-end vineyard in Virginia that had spent boatloads of money on a state-of-the-art winery and vineyards. And yet the vineyard was plagued with all sorts of problems, including poor soil drainage, and dubious variety, rootstock and trellis choice. I asked Lucie whether it would help if they brought her in now, after the design and development phase, and her response in a nutshell was: No, it's too late - so many of the critical decisions that impact wine quality have already been made and many of them were wrong, and it would be too difficult or expensive or both, to correct them mid-stream.

How could a smart owner spend tens or hundreds of thousands of dollars developing a vineyard and yet do it wrong? Sadly, it happens all too often. Vineyards are a long-term endeavor and the quality of the wine is determined largely by the quality of the grapes. The pre-plant decisions are the most important ones to the success of the entire enterprise. Every project begins with a knowledge gap – inherently with regard to the site itself, and almost always for those intending to plant the vineyard. It is up to the owner to figure out how to fill that void. The beginning is precisely the time to seek expert advice and build a knowledge base that will determine the quality of the wine, from the first bottle to the one made 25 years from now.

Even with the most rigorous research and preparation, however, there are plenty of upfront unknowns. Will anyone buy the wine? Will the critics praise it? Will you be able to recoup your investment? Your success depends on what you decide to do now. Vineyards are sensitive and complex living organisms where little things may make a big difference and you can never pay too much attention to detail. They are also business enterprises that require skill in bookkeeping and marketing. Our society underestimates and lacks appreciation for the tenacity, skill, and passion of the farmer. You will have to bring multiple skill sets to bear on a vineyard to have any hope of succeeding. While much about the grapevine is not yet understood, what we do know must be exploited to the fullest extent possible, especially when dealing with the difficult climate conditions of eastern North America. Give yourself plenty of time therefore to navigate the planning and development process. This will pay large dividends in the short and long term, and in what ends up in the glass.

This manual is a compendium of what I have learned over twenty years as a wine grower and ten as a viticulture extension educator. In my experience the most creative and innovative practitioners push quality further and faster than the best efforts of scientists to improve or explain viticultural results in field. A great deal of the information presented here is anecdotal – i.e., derived from what appears to work in the field, based on what I have observed in my own vineyard and learned from some of the best wine growers in the world and blended with some of the best viticulture research in currently available. Remember that it constitutes one viticultural perspective among many. Your job is to find the best information for your site and to apply it thoughtfully and correctly.

I invite you to visit the Pennsylvania Wine Grape Network website at <http://pawinegrape.com> for more wine growing information and an archive of articles and newsletters.

Good luck, and above all, have fun.

Acknowledgements

I have had an exciting and fulfilling career in agriculture and wine that started with a love of wandering in the vineyards in the Rheingau region of Germany. I thank Helmut and Margot Ringsdorf, and Heinz-Wilhelm Dongess and Ulla Brunn for getting me in touch with the romance of wine and vineyards. When I look back, over three decades of adventures in winegrowing, I have been blessed and informed by a remarkably diverse, generous, interesting and fun group of people. This book tries to summarize what I have learned from them. Every day I encounter more people who love wine and want to grow it so I try to use what I have learned to help them to help others.

So many people have inspired me over the years but I think of great wine growers from Christian Mouiex at Chateau Petrus, Jeff Newton in Santa Barbara, Ted Casteel in Oregon, Jim Law in Virginia and so many others who helped me to connect the dots between the elements and the wine. Richard Smart has probably done more to improve wine quality around the world than any other individual. He is always an inspiration to wine growers.

This manual could not have been written without the help of many people. Lucie Morton, Steve Mudd, Jeff Newton, Nelson Stewart, and Rutger de Vink submitted to lengthy interviews to make sure this manual was relevant. 43 wine growers and extension educators helped by filling out the vineyard manual survey. Ed Boyce, Kevin Ker, Jim Law, Dr. Tim Martinson, and Mike Walsh were so gracious to agree to review the book when asked just as the 2009 vintage got underway. For me one of the best features of the manual are its sidebar contribution from an amazing who's who list of significant contributors to wine in America. Their words help to connect the contents to reality.

I am very grateful to my sister, Lisa, who graciously offered her time and talent to edit and review the manual.

A project like this is one part passion and five parts frustration and dogged determination. I cannot ever thank my best friend and cheerleader, Judi, for her patience and encouragement as I slogged my way through this process, and her outstanding editing skills.



Introduction

Author's note: *This manual is a guide to wine growing in the non-arid, continental climate conditions that are typical of the states east of the Rocky Mountains, where winter injury and summer rainfall form part of the reality of growing grapes. I will refer to this extensive region as the "East," but for practical purposes it means the region of the United States east of the Rockies and other wine growing areas with a similar climate.*



Karamoor Farm Vineyard

here are based on my personal experience as a wine grower on Long Island and in Oregon, but are also informed by ten years spent working with wine growers and learning from their triumphs and their mistakes in the East as an extension educator.

The quality of the vineyards in the East has vastly improved following an international trend towards better wines, facilitated by the development of new knowledge and technologies, such as precision site evaluation, novel varieties, clones, rootstocks, trellis and training systems, vineyard design, viticulture practices, etc. One of the main purposes of this book is to help you learn from, and hopefully avoid, the mistakes that plague most new vineyards. If you can do this you will have better grapes (and wine), earlier profitability, and experience less frustration, wasted time and expense.

It is important to remember that producing wine is all about agriculture. America used to be an agrarian society where most families lived by growing their food. While wine is not considered to be a basic staple in the United States, if you decide to go into wine growing you will become part of the agriculture community, joining the less than two percent of Americans still involved in food production. If you make this commitment, it should include the determination to produce a high-quality product using sustainable best practices in a close partnership with the land.

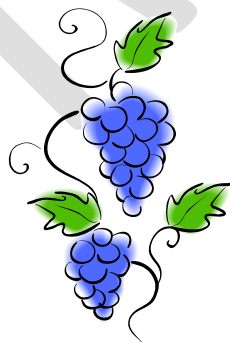
This book is first and foremost a practical guide to growing wine grapes (to be distinguished from table and raisin grapes, or fruit that will be processed into juice or jelly), and it will tell you how to do so as a commercial business, i.e. grapes for sale to a bonded winery that makes and sells wine. Targeted at serious wine growers who will shape the reputation of Eastern wines, it attempts to explain how to turn an idea into a high-quality wine grape vineyard, outlining the sequence of steps involved in planning, designing, preparing, and planting a vineyard, and then nurturing it through its first years. Each phase has specific requirements that demand careful attention to detail if you want to achieve a profitable and sustainable vineyard.

This manual does not pretend to be an academic textbook. Much of the information it contains is anecdotal, firmly based on an empirical approach to viticulture. The fact is that in this field almost every idea or practice is still open to debate. While there is a great deal of science to support standard viticultural activities, there is just as much that we do not understand about the vine and how to cultivate it. This is why successful viticulture requires a broad approach to knowledge acquisition, learning from trial and error, listening to other growers' experiences and to one's own intuition, and drawing on sources from the Old World and the New that may be applicable to our local conditions.

For this reason, the manual contains practical advice that may not be easily found elsewhere. However, to fill in any possible gaps, a carefully selected list of reference resources is provided. There are many excellent production guides available, and you can also Google key words to pull up a wealth of information. The perfect complement to this manual is *The Wine Grape Production Guide for Eastern North America* (2008), edited by Dr. Tony Wolf, and I strongly recommend that anyone beginning a vineyard development project use these two resources in tandem.

Growers prefer above all to learn from other growers. As a check on the contents of this manual, a survey was conducted among fifty leading wine growers, viticulture consultants and researchers in the Eastern wine industry. They have provided many valuable insights based on their personal experience. Extensive interviews with some of the most progressive and successful growers and consultants working in the region have, I believe, added a greater depth of experience to this work. For the convenience of the reader, their input on some especially important topics is presented in the form of sidebars. Finally, five of my most trusted and respected viticulture friends have reviewed this manual and their fingerprints are all of this work.

The goal of this manual is to contribute to the establishment of a regional wine culture in all wine categories that will earn international respect and recognition. This is an exciting time to be a part of the Eastern wine industry and you will be one of its pioneers.



Chapter 1

A Great Tradition and Your Personal “Ah-Ha” Moment

Wine has been around for a long time. Before water was safe to drink, beverages like wine and beer helped to sustain mankind. Dr. Patrick McGovern, an archeochemist at the University of Pennsylvania observed, with reference to the symposia of ancient Greece, that wine was a beverage that “greased the skids” of Western civilization. Beginning with the hawthorne berries that were used to make a fermented drink nine thousand years ago in China, and continuing with the cultivation of grapes by the Egyptians, Greeks and Romans, wine has formed an integral part of the culinary, religious, and social history of man. We have evidence that the ancient Egyptians practiced viticulture, and the Greeks conducted a brisk industry and trade in wine. The Romans pushed the grape into France and Germany, thereby planting the seeds of the tradition that is so venerated today. Despite this long history, the fundamentals of winemaking and the plant itself have not changed; wine is still fermented by yeast using grapes of the same botanical origin as those that existed millennia ago. Wine and other alcoholic products always accompanied territorial expansion. We know that William Penn brought vines with him when he arrived in the New World in 1684.

We now live in a global age of viticulture and enology, extending from Italy, France and Germany in the Old World to new regions such as Australia, South America, the United States and others, all employing and refining modern viticultural methods that have improved wine quality and contributed to an increasingly competitive marketplace. For example, vertical shoot positioned training has replaced many traditional systems and is now used in almost all of the great wine districts. Such shared practices and methods are just one reason why wine is so fascinating. We can now make direct comparisons between Cabernet Sauvignon grown on the left bank in Bordeaux with that grown in Virginia or Napa Valley. Viticulture and enology speak a common language, and wine growers can travel to different countries to talk shop and learn something new. So while the wine industry in the East is still in its infancy, relatively speaking, it has access to the same knowledge and technology that is being used in the great vineyards of the world.

Most vineyards start with a love of wine, and an idea that turns into a passion, but after the light bulb has been switched on ... where does one start? Most people who contact the cooperative extension service for advice about grape growing are at the mid-point or near the end of their professional careers, when a vineyard and life as a gentleman farmer as a retirement business or serious hobby looks extremely attractive. A top consultant describes his typical client as “educated, wealthy, ambitious and burned-out.” The timeless and irresistible allure of wine is understandable, but the truth to be faced is that if you have come to wine and agriculture later in your life, you will have to overcome immense challenges.

Every vineyard is unique and yours will be your own creation. It begins with the site, and your task will be to get to know this site and its terroir so that you can adopt the most suitable viticulture techniques to it. Terroir refers to the complex combination of soil, climate, plant and viticulture factors that intermingle to make a wine expressive of the place where it is grown. In France and Italy the wine growers’ understanding of their terroir has had the opportunity to mature over the course of centuries, leading in some places (such as the Mosel, Rhein, Alsace, Burgundy, Bordeaux, Piedmont, and Tuscany) to wines that are regarded as benchmarks for the rest of the world.

In the East our aim is to speed up this process, using all the tools at our disposal to identify the best places to grow and make wine. Eastern wine is characterized by a diverse range of grape varieties. This can be both a blessing and a curse. Standard native and traditional hybrid varieties such as Concord, Niagara, Marechal Foch, Baco Noir, etc., make up the core of the wine industry and for these varieties production practices are well understood and implemented. However, the process of developing high quality hybrid and classic European *vinifera* varieties is still underway.

Before you begin, you should be aware that there is no formula for creating a successful vineyard. There are prescribed steps that have proved successful elsewhere, but everything must be adapted to the particular conditions of your site. You should expect information overload almost immediately. If you are not good at collecting, processing, and synthesizing large amounts of data and making educated decisions you will have trouble developing a high quality vineyard. There are practices shared around the world, but your site is unique and you will have to find the best combination of plants (varieties, rootstocks) and vineyard design (spacing, trellises, etc.) and management practices to apply to it. To add to the confusion, like any computer operating system, there will always be more than one way to achieve a given result and you will have to decide which one is the best for you and your site.

Another of the realities of grape growing is that it involves the art of compromise. A vineyard begins with an ideal concept in the mind or on paper and then works steadily towards the closest approximation of it. Remember that there is no perfect site (although there are definitely better and worse sites), and furthermore every decision you make about one thing will have an impact on dozens of others. The best approach is to view the vineyard as an aggregate system and not focus on its parts in isolation. If you do, you risk design and decision gridlock. A vineyard is by definition a monoculture system, and what is worse in the case of the classic European varieties, places a non-indigenous species, Old World *Vitis vinifera*, smack in the middle of a number of New World enemies – diseases and pests such as phylloxera, powdery mildew, downy mildew, etc. that are native to the Eastern U.S. Nature prefers diversity, so introduce your vineyard gently into its environment and give it time to assimilate.

It is important to be aggressive in the pursuit of knowledge, and decisive in its utilization. Seek the best and most reliable advice you can find from a multitude of sources. The result will be gratifying – a wine that is unique to your vineyard. A very wise grower told me recently that when he started he didn't know what he didn't know. That is a dangerous place to be. It is essential to fill that knowledge gap quickly and correctly. He further explained that if he had hired the expert consultants he has now, he would have cut his time to fine wines in half or more.

NOTE: A core assumption of this guide is that the reader's intention is to grow the highest-quality grapes possible for a given type, style and price-point of wine.

If the reader does not accept this as a core value, then this manual will probably not be very helpful. In the wine industry there is an oft-quoted saying that: "Fine wine is made in the vineyard." The best growers and vineyards are dedicated to this truth. Although winemakers are the "rock stars" of the wine world and growers remain in the background (doing most of the hard work, it will seem), the fact remains that no outstanding wine is possible without the best fruit as its raw material and all great wine producers fully understand this.

A note on terroir

This elusive term has been embellished, marketed and politicized for the past two decades in the wine world, beginning with the French who (quite understandably) use it to add mystique to their wines. While difficult to describe and virtually impossible to quantify, it does convey something of the complexity of growing a wine and may be useful in that sense.



What makes the wine from these Cabernet Sauvignon vines in the Medoc so special?

the sun and assign the highest value to the influence of climate. In California and other arid regions, climate drives the definition of terroir. So this is a very malleable term depending on one's viticultural heritage and perspective.

In the East, as in most emerging wine regions, viticulture is often given precedence over site characteristics. However, as wine regions mature (Napa Valley, Oregon, etc.), the qualities of site emerge and are more fully understood and appreciated. As the subject is so difficult to research, there is little data to support hypotheses regarding terroir; for example, many wine connoisseurs are convinced that the mineral, stony, chalky or slate character of a wine is a direct expression of the soil, but scientific evidence only points to an indirect influence of soil on the flavors that appear in a wine. This is hardly an answer suitable for wine writers and their flowery prose, but we cannot ignore science altogether. In the end, the wine grower must rely on his skill and the sensitivity of his palate to discern and then manipulate the innumerable factors that go into the creation of a wine. My advice would be to try and grasp the practical implications of the terroir of your vineyard, and not get bogged down in the abstract concepts or poetry.

Terroir exists everywhere and not just for vineyards. All artisan foods may be said to be a product of their terroir. A potted plant has its own terroir. For the purposes of this manual, terroir is the combination of components in the ecosystem of the vineyard that contribute to a wine's "somewhereness" (from Matt Kramer; now there's a great scientific term if there ever was one). The French worship the soil above all else in terroir, but how can we explain the highly praised *garagiste* wines emanating from the lesser vineyards of Bordeaux, where small producers employ extreme viticulture methods to make up for site deficiencies? In arid wine regions the tendency is to worship

Chapter 2

The Truth about Continental Climate Wine Growing

There is one thing that every prospective wine grower will eventually learn about growing grapes in the East: it poses a more complex set of challenges than almost anywhere else. In fact, after ten years of experience here, I can confidently state that this may be the single most difficult place in the viticultural world to grow fine wine. Serious threats to wine quality abound including winter injury, hurricanes, drought, diseases, pests, summer rain and humidity to a degree of severity and intensity unknown in other wine regions. These risks would be considered unacceptable to colleagues working in more conducive conditions such as California, and many openly wonder why wine growing is even attempted in the East.

What does this mean in practical terms? It means that you must introduce nothing less than best practices in the vineyard, because if poor conditions develop it will be difficult to achieve acceptable results with anything less. Even so, there will be years when despite a heroic effort the grapes will struggle to attain even standard quality. The truth in agriculture is that during poor years farmers will expend tremendous amounts of money and effort and see only a modest or poor return, whereas in good years great grapes appear with relatively little effort and expense. In the East every vintage will put you to the test and if you limit your investment in terms of time and energy you will achieve mediocrity at best. You simply have to be a smarter and better wine grower than your counterpart in any arid region to achieve consistently fine wines.

One's approach to viticulture is always dictated by the growing conditions. Eastern wine growers must strive to reach two goals. First, they must shorten the vegetative cycle of the vine in order to get the fruit ripe as early as possible and beat the various harvest threats to quality: rain, rots, birds, frost, etc. Secondly, for vineyards in cold regions such as north of the Mason-Dixon line or in the Midwest, they have to get the wood as mature as possible to achieve maximum cold hardiness during the winter to insure bud and vine survival. Fortunately, best practices are generally consistent with both of these objectives and everything that is done in the vineyard – from selecting a good site to assigning the correct variety and clone, and the right rootstock for the soil and climate – directly or indirectly addresses these two goals. For example, retaining leaves for a period after harvest in cold areas will contribute greatly to the cold hardiness of a vine.

The quality of Eastern wines relative to global benchmarks has been slow to improve in large part because viticultural quality has not reached a standard to produce such wines. Great strides are being made in all categories of wines but the current consumer perception of Eastern wines reflects the challenges they face in the vineyard. All new growers are obligated to rise up and meet these challenges if fine wines are to be produced.

The Importance of High Quality Viticulture in the East

*Jim Law, Vigneron
Linden Vineyards, Linden, Virginia*

Precise, well-timed winegrowing pays the greatest dividends in Eastern North America for one simple reason. It rains a lot. We have more rain during the growing season than just about any other viticultural region in the world. This abundance of rain makes our vines more susceptible to disease, excessive vigor, and grape and wine dilution.

This is a painful fact that I have come to accept. Most of my management decisions are based on mitigating our wet climate's influence on my wines. It gives me great comfort to taste wines from two other wet winegrowing regions that I have learned so much from: Bordeaux and Burgundy.

Vineyard establishment decisions are critical in reducing the negative impact of a wet climate. My best wines come from soils that are well drained and have a low water holding capacity. Steep slopes are an additional plus. Once these critical decisions are made and the vineyard is planted, the difference between good wine and great wine is often the ability of a grower to execute good canopy management. I define canopy management as the manipulation of shoots, leaves and clusters in a way that enhances sunlight interception, canopy drying, and most importantly, wine quality. If a vineyard planting is well thought out and the vines are naturally in balance with their environment, then canopy management work is greatly reduced. If the vines are not in balance, then the only way to produce great wines is by using a very heavy hand in the vineyard. This is expensive in terms of labor and is referred to as "Band-Aid" viticulture.

There are four basic vineyard tasks that can make or break wine quality. **1. Shoot thinning.** In the spring when the new shoots are young and tender, we reduce the number down to about two shoots per canopy foot. This opens the canopy and is our first round of yield control. **2. Shoot positioning.** In order to have an airy open canopy, we separate and tie shoots so that they are uniformly spaced. **3. Leaf and lateral pulling.** Just after flowering we begin to remove leaves and lateral shoots from around the clusters. This allows for better drying and spray coverage. **4. Cluster thinning.** Most of the summer we are removing young clusters in an attempt to bring yields down to a level that I feel will give my wines concentration and expression of terroir. For red grapes I aim for one pound of grapes per foot of canopy. Whites may be somewhat higher.

These canopy management techniques are used by the best growers world-wide. I believe that at this stage in our viticultural development, precise canopy management is more important than terroir or winemaking ability. This is nuts and bolts farming. It is not sexy and has limited PR value (as opposed to new clones, oak barrels or French consultants), but it is what works.

*Author's note: Jim was a contributor for many years to **Wine East** (now a supplement to *Wines & Vines*) and **Practical Winery and Vineyard**. His articles are well worth seeking out and reading. He also wrote **Backyard Vintner**, a homeowner's guide to growing and making wine. Linden Vineyards is a premier wine estate in the Mid-Atlantic region and a visit there would be very educational.*

Despite these difficulties there is no shortage of enthusiastic grape growers in the East. Why? A valuable lesson I have learned since I arrived here is that people can become deeply attached to the place where they live for a variety of reasons. They may love and want to make wine, but they want to do it on the farm where their parents and grandparents lived and perhaps farmed themselves. This is a deeply rooted motivation. Many of the well-endowed clients I work with could own a vineyard in Napa or other areas where the wine comes easily from the terroir but they choose to stay close to home. From the perspective of quality and ease of production it makes little sense, but from a human standpoint is understandable. The difficulty for the extension educator or consultant is to match viticulture to a lesser site instead of choosing an ideal site to suit the wine type and style being striven for.

Before continuing, therefore, I must relay a cautionary message. We have many viticultural tools available to us, but all the knowledge, skills, tools and positive thinking in the world may not be sufficient overcome the forces of nature and the hard-to-please consumer with a globe of wines to choose from. The underlying truth is that the site features remain the key to high-quality grape production and whatever you sacrifice in terms of site quality will only increase the challenges and obstacles that you will face.

Chapter 3

You and Your Vineyard: Making the Big Decision

The development and management of a vineyard is not rocket science; grapevines will grow just about anywhere and, once established, are actually quite difficult to kill. All the same, to produce a grape with the potential to make a fine wine requires a specific set of skills, knowledge and temperament, not to mention the financial wherewithal. In the case of fine wine, you get out of it what you put in, nothing more. Qualities to be found in the great wine grower include passion, patience, persistence, flexibility, attention to detail, organizational skills, creativity, curiosity, intelligence, the capacity to observe, communication skills, and above all the willingness to work hard. Begin by looking in the mirror.

The realities of farming

At its core, farming is about problem solving. If you do not fancy yourself as a problem solver you should avoid agriculture. Every day the vineyard will present you with a series of problems that must be resolved. Can you do it? Furthermore, you will be at the mercy of Mother Nature. Each day's effort will be guided by the weather. How flexible are you? To be comfortable in this business, you need to have a high threshold for such stresses.

At present most of the people entering the wine industry come from other careers and often begin as serious hobbyists. Unlike in Europe, it is unusual for a person in the States to grow up in the wine business, although we are witnessing a second generation of wine growers in the East. And despite our agrarian heritage, most Americans are woefully lacking in any knowledge or appreciation of agriculture, and just assume that farming cannot be all that difficult or complicated. If this is your conviction, then you need a reality check. In fact, there are few more multi-faceted, financially risky, and intellectually and physically challenging jobs than running a farm. You may have been captivated by the beauty of a wine road in France or California, but the romance will be hard to recapture during a soggy harvest, or on a blazing hot day in August, or when pruning in a bitterly cold wind in winter. Unless you can afford to delegate all the work, you will be dirty, sweaty, wet, hot or cold, and tired most of the time.

While there is profound satisfaction to in working the land and making wine, but most of the romance associated with wine is found in the retail and consumer experience. If you genuinely yearn to own a vineyard, you will have to accept the fact that your daily routine will be one of hard work with delayed or limited financial rewards. Oh, and just to add insult to injury, if you manage your own vineyard you can forget about those leisurely summer vacations with your family – miss one spray application and the entire crop could be lost to disease. Be aware of the demands of the vineyard before you commit yourself to it.

All of this is being explained not to scare you off (well, it is meant to scare you), but to put you in the picture and help you realize the responsibilities you will be taking on. I, and every person in the wine industry in the East, have a stake in your success. We need you to make good wine, because as the industry strives to improve its products and establish its reputation, every substandard bottle has a disproportionately negative effect. If a consumer is served a bad wine in Napa Valley, he will just drive over to the next winery and try another. If he tastes a poor wine from Pennsylvania, he is likely never to try another and will tell all his friends to avoid local wines. It is therefore in every wine grower's interest to help his neighbor succeed.

The unique challenges of growing wine in the East

As we have already noted, the region poses many problems in terms of wine growing and an important preparatory exercise for you will be to study these challenges and determine how you might overcome them.

The central question is how to grow grapes in a warm, humid, rainy climate that promotes disease and insect pests beyond the worst nightmares of wine growers elsewhere, with the threat of winter injury on top of that. Rain at harvest is probably the greatest test of all. Under these conditions, you will have to work harder than your competitors in the drier western states to attain the same quality, and even harder to excel. Consumers and critics may be aware of vintage variations, but in the end what they are concerned about is the price and quality of what is in the bottle, not the work that went into it. Do you have the dogged determination that it will take to satisfy them?



Vineyard Family at Pinnacle Ridge and Round Ridge

The bottom line is: Can you be a farmer? Or even a gentleman farmer? Be honest. Can you put up with humid summers and being perennially hot, sweaty and dirty? What about being cold, wet and dirty in the winter? Will gnats and flies buzzing around your head for endless hours while you pull leaves drive you crazy? Are you able to spend eight hours on a noisy tractor driving at 3 mph and cover just 24 miles? A lot of the work will be repetitious and menial, and includes simple cleaning and maintenance work. On a farm, things are always breaking and your success depends to a surprising degree on your

ability to fix implements and machinery quickly. You are likely to develop a bad back, tennis elbow and carpal tunnel syndrome, and will find yourself visiting your doctor or hospital after the occasional accident like when you hit your thumb with a hammer. Do you manage people well? Do you speak Spanish? Consider these factors seriously before you cast your lot as a farmer.

Inspect thy wallet

As with any new business, to be successful you must work out the economics of your project. Do you have the financial resources to build this business and not compromise either the vineyard or the quality of life you are accustomed to? Read Chapter 8 carefully. You want your project to be viable and this means staying within a budget and not going broke trying to make wine. If you want to make a really good wine, you must accept that there is a strong correlation between what you invest and the quality of the wine that comes off the bottling line. What are your goals and how much are you willing to spend to get there?

Time

This is a long-term project, so ask yourself, “Why am I doing this and where do I want to be in ten years?” We live in a culture of instant gratification, but the vines cannot be hurried.

Do you have the resources, stamina and attention span to go the distance and is there a plan for who will tend the vineyard after you are gone? Do you have the flexibility at work to take time off during the busy harvest season to bring the grapes in?

Another aspect of time – a precious commodity these days – is the problem of who is actually going to do all the work. If the answer is yourself, then you should immediately begin a survey of vineyard owners to get a realistic notion of the workload involved, and then measure it against the time that you will have at your disposal for the project. Vineyards involve a great deal of hard labor. Be prepared to toil after your day job, on weekends and intensively during the summer. Vines have their own schedule and you will be obliged to adjust to it.

A corollary question is: Will the vineyard require professional intervention and seasonal labor and if so, are you a good manager and “people person”? Can you deal with field workers on a daily basis? Would you consider learning another language in order to be able to communicate better? Human resources is one of the thorniest issues in agriculture, beginning with the problem of the general scarcity of agricultural workers on the East Coast, from managers down to skilled field labor and finding legal seasonal workers.

It is crucial that the family be on board with this idea. You will probably be working in the vineyard on evenings and weekends and not everyone approves of a vineyard mistress. It takes time and money to develop and maintain a vineyard – both of which are probably already in high demand in your family. You will be absent for long stretches during the summer, when your presence will be required to hedge and spray, and at harvest when you will need days or sometimes weeks to get the fruit from the vines to the winery.

Risk

Finally, what is your risk threshold? Your investment portfolio will probably give you an idea of just how much risk you are willing to take on, and if you don't have an investment portfolio you probably don't want a vineyard. In fact, a good analogy to this business is the stock market; both are extraordinarily sensitive to the vagaries of nature and the consumer.

Agriculture is by its very nature unpredictable and an upper-end commercial vineyard is not for the faint of heart. According to Jim Law at Linden Vineyards, fortitude is the hallmark of the successful wine grower. A lot can go wrong during the course of a year. Given the unpredictability of nature, a vineyard requires the capital to withstand periodic crop failures, or vineyard injury that may result in the loss of income for an entire year or successive years. Talk to other growers as if you were talking to your financial advisor and then assess your ability to absorb the risks involved in the business. It's better to find out now rather than later, so you can either move forward or step away from the project.

The best wine growers are passionate about their vines but combine this quality with patience, dogged determination and a pragmatic attitude. The pursuit of fine wine is a life-long endeavor in which one is always learning and adapting. If the prospect does not fill you with enthusiasm, then you should probably let others grow the grapes and simply enjoy the fruits of their labor. There is no shame in that and you will be one of their most knowledgeable customers.

Chapter 4

Grape and Wine Quality Defined

Quality is a term that we use incessantly in our consumer culture, and yet it is highly subjective. We may think of the Mercedes as a high-quality automobile, but mechanically it probably does not have any more quality built into it than a Toyota. Each of us has a personal sense of what constitutes a poor, good or even great wine. In this manual, quality refers to the production of wine grapes and wines that meet international standards for the class or style of wine in question. Quality can exist in every category of wine, from box and jug wines and so-called ‘fighting varieties’ to the very expensive cult wines. However, each of these wines requires quality grapes to make a sound product. And quality grapes means establishing a well-designed and well-managed vineyard that is capable of producing uniform, fully mature grapes that are free of disease and defects and (where necessary) a cold hardy vine that can survive the winter.

In setting your goals, it is important to apply generally accepted standards – local, domestic and international – within each wine category to define the quality of your product. Wines exist along a continuum and there are quality wines, based on clearly defined criteria, at every point. However, if you toss in individual preference, stylistic differences, vintage variation and a host of other factors, you will understand why quality is such a subjective measure.

The viticultural approach will vary with the type of wine, and quality must be built into every phase of the vineyard operation. Developing a vineyard is something like building a house. How many of us could construct one from scratch with no prior experience? Some people will act as their own general contractors and acquire enough knowledge as they go along to successfully complete the process. Others will hire someone to do all the work and then step into an operating-management role. It’s also possible to purchase a turnkey operation with management, labor, market and reputation already in place. Electing to start with a bare piece of land means a complex endeavor with a great many decisions that have to be right if the whole structure is not to collapse. There will be a correct way and a wrong way to do things, and in many cases a short cut as well, but most of the time the long road will be the best choice. It may be more expensive and time-consuming, but it will pay dividends in the wine.

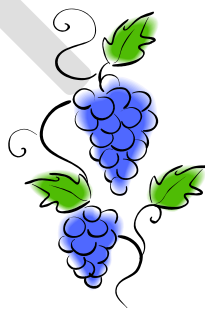
Vineyard development involves hundreds of questions and the success of your vineyard will depend on your ability to respond with at least an educated guess in each case. Because vineyards are a perennial crop, downstream adjustments can be expensive, and often impossible short of tearing out the vines, so it’s better to get it right at the start. The process begins by asking the right questions and gathering relevant, high-quality data; don’t hesitate to consult as many growers, winemakers and consultants as you need to. Then you can create options and choose what appears to be the best solution. Finding the answers will be time-consuming, but look on it as an adventure.

Every wine region comes with its own traditions. In the East the post-Prohibition wine industry began to expand in the 1960s based native and hybrid varieties developed over previous decades. The practices applied to the cultivation of these varieties do not always meet the needs of European varieties. A vineyard in the Medoc, for example, represents the product of centuries of observation and study of what, where, how, and why specific viticulture phenomena occur and how they impact wine quality. In trying to grow the best grapes possible, your goal must be to answer as many of these questions as you can, drawing on the experience of others and on the

latest developments in materials, viticulture practices and so on, in order to create a vineyard on a site that lacks such a historical record.

To attain your quality goals you should learn both traditional and modern practices. Regions such as Australia and California used technology in the vineyard and cellar to close the quality gap with their Old World rivals, but then circled back to integrate traditional methods, especially cellar practices, to give their wines a more artistic imprint. Technology and tradition should not be considered antagonistic; in fact, Old World regions have adopted practices from the New World to help them make better and more consistent wines (using the rolled steel pencil stake rather than the more traditional string to train new vines, for example). We are not dealing with either-or situations and often a carefully chosen combination of old and new practices may be ideal.

Vineyard size is an important decision that has quality implications, because it will directly impact the amount of time, effort and money you will be called upon to invest. A commercial wine vineyard can exist in any size from a few vines to thousands of acres (most in the East are small by comparison to those in Western states) but it is always important to remember that the goal is quality, not quantity. The advice offered by experts to new growers is to start small and expand gradually with the experience that you have gained from farming within the limits of your means and ability. Too much vineyard will end up sacrificing quality, with possible long-term vine health and productivity consequences. It is more rewarding to grow fewer high quality grapes than a lot of mediocre grapes. Smaller vineyards have higher unit costs, but are more manageable. Keep in mind that vineyards are very sensitive to neglect; if at any point you lose interest, your lack of enthusiasm will almost immediately show up in the quality of grapes and the wine. Before making any grandiose plans, keep in mind that a ragged-looking vineyard may not compromise quality, but the perception of winemakers and the public could be adversely affected. To ensure quality, don't bite off more than you can chew. Develop a sound business plan and make sure you know where to get help when it is needed, before you are overwhelmed by the costs and the amount of work involved.



Chapter 5

Time and the Vineyard Timeline

How much time does it take to get from an idea to vines in the ground? The best growers will say anywhere from 6 to 18 months, not including the property search, but it is actually impossible to predict because it depends on so many variables: how much time you have to research the project, the land evaluation and preparation process, the availability of vine materials, and so on and on. The planning and development phase must be flexible and should never be hurried.

A vineyard has a different pace from most things that we are accustomed to in our hurry-up, get-it-done-yesterday culture. After a vine is planted, it typically takes three years to reach the first harvest, and another ten before the true nature and potential of the vineyard is revealed. If red wine is being made, it will probably not be in the stores for another year or two, and sometimes more, after the grapes are harvested. But if the vine stays healthy it can produce fruit for twenty or thirty years or more. Clearly, this is not a business for those who are in a hurry to clear a profit or drink their own wine. In Europe vineyard time is marked in centuries, with generations of owners lovingly cultivating the same small plot of vines. The *vigneron* makes decisions that will have consequences for his children, and quite possibly his children's children. This is the cycle and pace of the vine. If you are entering the business to escape the rat race, then you must be prepared to put on the brakes and live according to vine time. Hasty decisions will compromise the quality of the grapes and, ultimately, the wine.

Everything begins with the site, and finding one should not take more than a year of focused property hunting, assuming that the general area you are looking at lies within the bounds of viticultural reason. The key to success here is to know beforehand exactly what you are looking for, and to find the right people to help you. Your viticulture education should be taking place simultaneously with this search.

Once you have a vineyard site, your time line will depend on the process of evaluation, planning, acquiring plant materials, and site preparation. If a field is being replanted from vines or fruit trees or is being cleared of forest, it should be left fallow for at least one year and up to two to three years if nematodes and soil-borne pathogens are present.

Variety and rootstock selection will be influenced by the site's characteristics, so at least this part of the evaluation process must be finished before you place an order. If grafted *vinifera* vines are a part of your plan, these should be ordered 15-18 months prior to April of the year that you will be planting. During the period that the young vines are being grown by the nursery, much of the site preparation work can be done. If you have chosen own-rooted or readily available grafted vines, the gap between ordering the vines and planting them can be narrowed considerably, but not to much less than the summer prior to the spring planting date if you are to get all the preparatory work done properly. The worst thing that a grower can do is to become impatient and rush the process. Wine growing is a slow and methodical process – from the growing season to the life of the vineyard itself. The best vineyards are carefully planned and never hurried, from the first crop to the last.

The following is a sample timeline for developing a vineyard:

1. The ah-ha moment
2. Find a vineyard site (0-2 years). Organize financing and create a business plan. Start collecting local climate data. Make contacts with winery customers. Begin your

viticulture education process. Attend workshops for new growers. Consider hiring consultants. Find a high-quality vineyard where you can do intensive internship work during the crucial summer, harvest, and pruning seasons.

3. Year 0 / Summer: Conduct soil evaluations when the soil is dry. Do GIS and GPS mapping of the soils, slope, aspect, hazards, and other topographic features that may influence development decisions. Create maps and an operational plan based on this data in which decisions regarding row direction, row length, vine spacing, trellis design, soil amendments, water development, cultivars, clones and rootstocks are made.
4. Year 0 / Fall: Order plant materials from reliable nurseries for planting in Year 2 / Spring. Clear the land and plant a winter cover crop.
5. Year 0 / Winter: Continue self-education and planning for the upcoming season, review your budgets, engage in networking, and attend winter meetings.
6. Year 1 / Spring: Begin infrastructure development, including roads, fences, water source, etc. Carry out preliminary soil preparation and weed control.
7. Year 1 / Summer–Fall: When the soil is dry, carry out soil preparation including ripping, disking and leveling, and soil amendments. Do weed and vertebrate control. Install underground irrigation parts, develop surface and subsurface drainage (if the rows have been mapped). Check the progress of the vines at the nursery. Attend summer field day meetings.
8. Year 1 / Fall: Carry out weed control and plant a winter cover crop, order trellis materials, reserve a laser planter.
9. Year 1 / Winter: A trellis system can be installed if you are hand-planting. Make provisions for your labor needs. Continue to develop infrastructure projects. Review your budget and organize spring activities. Attend winter meetings.
10. Year 2 / Spring: Final field prep, layout and field marking. Receive, prepare and plant vines. Install surface irrigation parts and trellis system. Grow tubes can be put in place.
11. Year 2 / Summer: Early vineyard care begins: early training and suckering based on vine vigor; replants; weed control. Irrigate and fertilize as needed. Spray vines for insects and disease. Remove grow tubes in late summer. Monitor vines closely for any problems.
12. Year 2 / Fall: In cold areas, hill up over graft unions.
13. Year 2 / Winter: Review the entire growing season; determine what went wrong and what went right. Plan what needs to be done in Year 3. Attend winter meetings. Prune according to vine size.

During this entire process you should be educating yourself about growing wine, tasting local wines, visiting vineyards near and far, attending meetings and workshops, networking, and so on. As we shall see, the learning process never ends.

Chapter 6

Education: Filling the Knowledge Gap

Most people who enter the wine industry today have little more experience with agriculture or growing grapes than a stroll through a vineyard in Napa Valley or Bordeaux. The first question then becomes: How can one close the knowledge gap and turn an appreciation of wine into a skill for cultivating vines? This can be done, but how?

It is difficult because it involves effort, and time that busy people simply do not have. But it can also be interesting and fun as an understanding of the story behind a wine develops and new people and places are encountered. Developing a high-quality vineyard requires finding and utilizing knowledge properly and, like any other discipline, there is much you need to know to do it well. Knowledge will lead to experience, and eventually you will become a wine grower. There is a lot of homework involved in establishing a vineyard and the learning never ends, even after you are successfully growing grapes. Most growers say that it takes at least ten years to get to know and understand a new vineyard so, even after the vineyard is planted, it is constantly providing feedback to you about the site and vines. Whether in a structured learning setting or on your own, there is a strong correlation between the amount of effort you put in before and during the vineyard development process and the quality of the grapes the vines will produce. You may be tempted to give short shrift to this part of the project because of other commitments but the results will show in poor early fruit and wine quality.

Acquire the necessary know-how for the style and type of wine you want to grow, beginning with the basics of viticulture, which then can be tailored to your goals. There are various options available ranging from formal study to self-learning and the school of hard knocks. There are outstanding two- and four-year curriculums in viticulture and enology at schools across North America. These range from practical, hands-on vocational training programs at community colleges such as Chemeketa Community College in Salem, Oregon, and Surry Community College in Dobson, North Carolina to full-scale undergraduate and graduate studies at Cornell University and the University of California at Davis, to name just a few. Formal schooling with a solid grounding in biology, chemistry, and the plant and food sciences may seem daunting, but will certainly help to make you a better wine grower and winemaker.

You will emerge prepared to make critical decisions, but what will still be missing are the practical skills needed to master the daily tasks in a vineyard or winery. Many programs have practicum components that involve internships or other types of training in the wine industry. Hands-on experience can be the most valuable form of education of all, so find a good vineyard or winery that will let you help prune, drag hoses, and work on weekends in the summer, during harvest and in the winter. The most motivated learner will target a region and producer whose wines are similar to those that he wishes to make, and will work for a significant period in that producer's vineyard and cellar. The best time is just before veraison and through the harvest season, when the vines are in full flourish and you can study at first hand all the principles and practices that bring the vine and fruit to the point of making wine. Even if you believe that you are prepared, you will manage your vineyard better if you get some real experience in a winery, and the same applies to the wine maker.

It is helpful to know conversational Spanish if you plan to have employees. Depending on how deeply you want to delve into other traditions and the type of wine you are aiming to make, learning French, German and/or Italian could also be useful.

Few Americans start out wanting to be grape growers or wine makers and even fewer will have the opportunity to learn this profession working in the family business. In fact, the people running vineyards and wineries in the East are generally self-taught and the majority are competent, a handful are outstanding, and some never quite figure out what is going on. If you want to excel, your chances will be better with some formal training. However, few newcomers to this industry can afford to spend long periods of time away from their family and regular job studying in a formal educational program. This means committing yourself to self-learning, which will require discipline, perseverance, and finding the right resources to help you reach your goal. Fortunately for the self-learner, there is a wealth of outstanding published and web-based teaching materials available. The new grower materials highlighted in the information resources list may eclipse the knowledge contained in a formal educational program.

Whatever approach you choose, be aware that there are programs and instructional materials of dubious quality from which you may learn incorrect concepts and questionable practices without realizing it. You should always check on the reliability of the resources you have decided to use. Verify the source! This is the only way to ensure the quality of your education. If you are going to enroll in a school, compare programs and pick the one that has a good reputation and will meet your needs. If you want to work at a vineyard as an intern or a volunteer, make sure it is a high quality operation with competent staff who can train you properly. If you are reading books, choose the highest quality texts that will fill your specific knowledge needs. Learning the wrong lessons or picking up bad habits that will hamper you and your vines until they can be corrected. It pays to take the time to find and learn from the best available teachers, books, vineyards, etc.

Experienced members of the wine industry will be one of your most valuable resources, but study as much as you can about viticulture and enology before you start talking to them. Busy owners and managers don't have time to waste on every person who strolls into the tasting room and says, "So, how do I start a vineyard (or winery)?" They have ways of detecting who is serious and who is not, for example, by introducing technical terms into the conversation in order to gauge a visitor's level of knowledge. Separate yourself from the crowd by showing that you can speak intelligently about topics like clones, training systems and vine density, and come prepared with a set of questions. They will realize that you are earnest in your desire to learn and most will be quite happy to share their knowledge with you.

You may even find someone who is willing to mentor you. Wineries and vineyards always need help. Having a passion for the work will offset your lack of experience. Valuable training can be gained by providing your services for free over a weekend or even an entire year if you can afford it. The secret is to find the right mentor, with a business that matches your goals and will provide you with the most relevant information and experience. To ensure a proper match, some preliminary scouting will be necessary. While they may be interviewing you for a position, you should be doing the same right back at them to make sure they can service your needs.

Visiting vineyards and wineries will form an essential part of your education, and you should be observant and analytical. These will no longer be casual visits for fun and mere wine tasting. Try to see what is being done and understand why. Ask intelligent questions, and determine how you can translate this information to your own vineyard. If it looks like the grower knows what he is doing, probe deeper and ask if you can take photos of the vineyard. Taste wines critically and purposefully. It is important to form impressions of what varieties will perform best in a given area. Eventually you will be making enduring choices regarding

varieties, clones and rootstocks, and what you learn at these wineries will provide helpful indicators of what may be successful on your site. Study how a vineyard or winery balances the marketability of a variety with its suitability to a particular area and vineyard site. Be sensible and courteous in the pursuit of information. Do not overstay your welcome. Bring the same list of questions along on each visit so you can cross-reference the answers from different sources.

Local information, especially if it comes from extension educators or farmers in the area with orchards or vineyards, trumps just about everything else. They have valuable experience, especially with regard to questions of climate and soils. They may even be able to help you with marketing questions.

The value of networking cannot be overstated, and now would be a good time to join your regional or state wine or growers association. Their members and programs can be enormously helpful in providing information and data about such things as varietal selection, climate, soils, etc. Do not be shy as a prospective wine grower to attend viticulture seminars, workshops, field days, etc. While not all of the information will immediately accessible to you, it is still worthwhile to see different vineyards and hear the language of viticulture spoken. Gradually everything will become clearer. This is the best way to learn about the latest developments in research and practice and also provides a good opportunity to meet fellow growers and to start building a viticulture network. Don't forget that you can also learn a lot in casual conversation.

Larger meetings and conventions will have trade shows that are packed with the latest gadgets for the vineyard and cellar. You can benefit greatly from attending the Unified Symposium held every January in Sacramento, CA and the annual conference of the American Society for Enology and Viticulture (ASEV). Wineries Unlimited, which is held in March, is the largest trade show and information symposium in the Eastern U.S. ASEV Eastern Section hosts a conference in a different part of the region each year.

Equipment, supply, chemical and fertilizer vendors can also be a useful source of information. Ask around or take the time to figure out who among them really understands vineyards and their products. Although you should not forget that their ultimate goal is to sell you something (beware of overly aggressive sales pitches), vendors can give you sound advice in their areas of expertise.



Dr. Richard Smart, the Flying Vine Doctor at extension field meeting, Waltz Vineyards, Manheim, PA.

Get to know your local extension service, an invaluable source of information and expertise. Just remember that extension educators are there to serve the regional or state wine industry as a whole and should not be viewed as free consultants. Extension educators tend to know the big picture of the wine industry better than the fine detail of vineyard development. But they are experts at directing you to helpful resources. They may make one or two visits to your vineyard depending on the nature of their program. Try to sense how much time they can spend helping you. Some extension programs offer specific workshops for people who are

considering planting a vineyard. This would be a good time to sign up for newsletters and get onto e-mail lists to receive practical information and announcements of upcoming viticulture and enology events (see information resources section).

There is more than enough published material to keep you busy and much of it is of excellent quality. If you are going the self-taught route, you will find books, trade magazines, and academic journals galore. Rely on trusted sources whether it's a wine maker, trade magazine but especially when using the Internet; Google "viticulture" and see what happens! Read as much as you can in all categories and disciplines. Viticulture texts are often broad in scope, so you should supplement them with the best regional information available. Integrate the practical with the technical, the theoretical and with basic science. Practical guides teach "how to". Basic science teaches "why". Do you really need to know the difference between the xylem and phloem of the vine's vascular system? Perhaps not, but it will help you to appreciate the complexity of vine anatomy and physiology and understand the why of certain practices. And, it is worth reiterating – always check on the reliability of the materials you will be using.



Five Philosophies to Ponder
Galen Troxell, Wine Grower
Galen Glen Vineyard, Andreas, Pennsylvania

1. **The vineyard is the heart of the business whether you are a grower or winery.** Quality fruit is essential for quality wine. Always consider the long-term effects of vineyard decisions on the health of the vines. Think of them like people, in that if overstressed repeatedly (over cropped, drought stressed etc.), subjected to malnutrition, or damaged by equipment ... they will become compromised and will not be as fruitful or produce the best grapes possible.
2. **There is no free lunch.** Farming is hard work and Mother Nature waits for no one, ever. The easy way out initially usually is the hard way later. Vineyard efficiency is mandatory and laziness is deadly. If this is not practiced, significant consequences will occur either through increased vineyard labor, reduced quality, lost contracts, retail staff pushing mediocre wine, or heartbreak. The strategy that has seemed to work the best and resulted in the lowest overall cost is to overstaff the vineyard, allowing for both 'catch-up' capability and the ability to deal with the unexpected. This means that time-sensitive jobs are performed when they are required in the least amount of time. Always, work with your crew, earn their respect and inspect what you expect from them. Don't ask them to do tasks that you would not do or to be productive under conditions that you could not tolerate. If it is easy to do correctly, it is more likely to get done right.
3. **Get the best expertise that you can find, up front and before you start a vineyard.** You will never know too much and no expert has all of the answers. Don't be frugal with the design costs; misguided choices will last the duration of the vineyard. However, an expert plan does not guarantee success or phenomenal wine; that takes years of assessing your site, varieties, market, and wine preferences. Remember the devil is in the details; a friend of mine refers to them as 'the golden nuggets.' You can get 90% of growing correct and still have severe problems. Many parts of the world have been growing grapes for hundreds to thousands of years. Even the newer regions require thirty plus years to gain respect and recognition. Things that growers in established regions think are trivial or common knowledge are often the missing details for greatness at your location.
4. **Always have a goal and vision in mind.** Remember that growing grapes is both a challenging journey and an agricultural process, not something that just happens. Think of the grape and wine industry like a life-long chess match that requires you to evaluate and calculate your next moves. Most of us get about thirty growing seasons to create something very special. Vineyards require many hours on a tractor and this is a great time to evaluate where you are with respect to your goals. Perseverant individuals as a rule win in the end. Each year is a new one that should build on the previous year. Evaluate what is working and what is not. Develop plans to address the shortcomings. Always invest in getting better. This is a global business with some of the most intelligent and driven individuals in the world working in it, so the competition is fierce.
5. **What is the definition of productivity in a vineyard?** One of the best answers I heard to this question was: 1.5 lbs per linear foot of trellis for reds and 2.0 lbs per linear foot of trellis for whites. Per vine or per acre is often used, but does not seem to do justice to the subject. For example, the difference between 7-foot row spacing and 10-foot row spacing with respect to the above definition is a 30% differential. Your location, site, variety and goals will impact the absolute numbers that will work for your situation. The 'row to row' spacing is the volume knob, and the 'in the row' spacing needs to provide a balanced vine that requires a minimal amount of inputs with respect to tools such as fertilizer or canopy management.

It would be well worth your time to visit vineyards in your area, in your region, around the United States, and abroad, as this will only help to make you a better grower. I call this intentional viticultural travel. At the advanced level, it may be the most effective way to learn about new and innovative ideas and practices. At the novice level it is less effective but still worthwhile. Look for the best examples of vineyard development and maintenance and try to understand why a particular vineyard may be special. Ask the growers intelligent questions prepared in advance, because the best ones do not simply ‘see’, they also observe, learn from others and put this knowledge into practice. Good growers connect the dots between cause and effect and often between multiple variables. If you want to grow great Merlot, visit vineyards on Long Island, in California, and on the right bank of Bordeaux. If you want to grow fine Riesling, there are lessons to be learned in the Finger Lakes area, Ontario, Germany, Austria and Alsace. At the time of this writing, Long Island and the Niagara Peninsula offer the best and most consistent examples of high-quality wine growing in the non-Western states and provinces. A tour of both these regions would be extremely instructive. You could even consider hiring a consultant to spend the day with you, visiting vineyards and explaining their practices.

The growing conditions in arid regions such as California, Chile and Australia are very different from those in the Eastern U.S., so their knowledge and experiences will need to be sifted and translated before they can be applied. However, California remains the source of most new technology and knowledge in viticulture, so close attention should be paid to anything coming out of that state.

The best wine growers travel extensively to learn what others do, but it is important to use common sense and apply what will work in your vineyard. New ideas can and should be brought home to be tested. The best vineyards are in effect experimental laboratories where growers can assess new methods, products and technologies in order to push quality ever higher. Even new growers may experiment with clones, vine spacing, trellis systems, etc., but any trial must be planned carefully and carried out methodically with clear objectives in mind. An extension educator can help you to design a simple vineyard experiment.

Those who dedicate their lives to agriculture know that their work is based on experience, intuition and faith. Just consider the astounding sight of bud break each spring. There are biological reasons for this natural phenomenon, but it is no less miraculous to witness and we go through each winter keeping faith that shoots will appear every spring. It is important to accept the fact that not everything we see in the vineyard can be explained.

Experience will come gradually, as you get to know your vines and how to best tend them, what works and what doesn’t. This will depend on your ability to observe and understand the complex relationships that make up the vineyard’s different parts – biological (Mother Nature), mechanical (man and his machines), and practical (the technical know-how of viticulture). Understanding cause and effect will make you a better grower: “I see such-and-such and afterwards so-and-so happens” or “I do this, and as a result that happens.” In the U.S. growers learn to scout their vineyards for signs of problems but our training is not a rigorous and does not have the weight of history to help explain things.

Intuition is a sixth sense that develops out of experience, a seemingly mysterious knowledge that is actually empirical in origin. Intuition is the ability to predict an event based on present conditions and data inputs, the weather being a prime example since it plays such an important role in every vineyard decision during the growing season. It takes at least ten years to develop a modicum of intuition in this business and not everyone succeeds. The Europeans seem to be the masters of empirical wine growing based on observation and reasoning; in historic

regions they use information and intuition gained over the course of centuries to produce their wines.

As a new grower, while you are learning and honing your skills you will probably need some guidance. The wine industry is well known for the generosity of its members in sharing information, because they realize that helping others will in the long run benefit their business and the industry at large, and chances are that someone helped them when they got started. Newcomers will often find fellow growers, producers and extension educators who are happy to share their knowledge, but you can only take so much advantage of their good will and you may eventually wish to enter into a more formal arrangement with a vineyard consultant.

Is a consultant really necessary? To answer this, consider some of the technical questions that will face you during the development process. Should soil pH be adjusted? How does climate data influence variety choice? What is the optimal vine density based on soil evaluation? Should I opt for a single or divided trellis system? Do these dormant bench graft vines have enough roots? How many pounds of seed per acre are needed for an adequate cover crop? Some of these questions are transitory but many have long-term implications for quality and success. You need reliable answers, and you need them quickly because the vines will not wait. Extension services are a great resource, but at present they are stretched to the limit. That's where consultants – on retainer and on call – can be a godsend to the novice vineyard owner who is filled with enthusiasm and ready to get to work, but is handicapped by a lack of practical knowledge.

Once you have defined your wine style goals, find the consultant or advisor whose skill set and experience matches your needs. A genuine meeting of minds is needed here. Do you want to produce a \$40 red wine or \$15 whites? The site requirements, vineyard design and viticulture will vary depending on the answer. The consultant will help you to ask the right questions, find the best answers, and source the right materials and services as soon as the project begins, thus bypassing your own steep learning curve. A good consultant provides real value on both sides of a decision, helping you to make the correct choice and monitoring the results after it is implemented. Gradually you will accumulate the knowledge needed to run things on your own, but take advantage at an early stage of the expertise of others.



Viticulturist Lucie Morton and winery owner Jonathan Patrono survey a future vineyard site.

Eastern conditions. Keep this in mind if you enter into discussions with them.

Before you commit to a long-term relationship with a consultant, seek out references and talk with some of their best clients. It's like trying to find a good mechanic or psychiatrist; the relationship has to click on both sides. If possible, go and look at some vineyards that they have helped to develop, because seeing (and tasting) is believing. At present there is a shortage of talented consultants working in the East so start your search for the right person as early as possible. Consultants in the Western states have top skills and resources, but their knowledge is skewed toward viticulture for arid regions and is not always transferable to

How to Find and Work with a Vineyard Consultant

*Chris Hill, Vineyard Consultant
Covesville, Virginia*

The first thing a new wine grower should do is to get acquainted with the local wine growing community, if there is one. Through your neighbors, you can find out who the consultants are and what the community thinks of them.

Some consultants have websites that can be found through state grape grower associations. In Virginia, you would Google the Virginia Vineyards Association. The bottom line is, if you ask around you can find help. If you are not inclined to ask around and get to know fellow grape growers, perhaps you should rethink your reasons for wanting a vineyard.

Are you the kind of person who utilizes and can seriously evaluate advice from someone else? It's okay at all times to reject a consultant's advice. The important thing is to understand why he or she gave you that advice. Your consultant can be your most important teacher, but it is also important to seek out all educational opportunities, through such entities as your state agricultural extension or, once again, your state growers' association. From an educational standpoint, your consultants should eventually work themselves out of a job with you, or into a greatly reduced presence because you should be learning.

When should you start seeking professional advice? If you are looking for land to buy, let a consultant help evaluate the proposed purchase. Site selection is the most important factor that you will consider and a good consultant is really worth the money here. If you already own the land, your consultant can give you the positive and negative vineyard attributes of your property; for example, which parts of your property will grow which varieties best.

Nearly everyone who plants a vineyard in Virginia has never grown a grapevine before in their life. Some have never grown a plant of any kind and now they want to plant and tend thousands. Don't be overconfident in your skills. Listen to your peers. They have been there, done that. **DO NOT RE-INVENT THE WHEEL.** Learn from everyone else's mistakes, and we have made a plenty of them.

Another important question is, how do you pay your consultant - by the hour, day, month, year, or job? If you pay by the hour, how do you know when to call your consultant? Remember, you have never grown grapevines before. If you think you are having a problem, well, just how big an old problem is it? Should you call in your consultant now and spend all that money? Or, should you wait and see how things go? If you are just starting out, pay your consultant so that you feel free to contact her or her anytime you want. This probably means paying a monthly or yearly fee.

Consultants like clients who ask questions and are a little paranoid. We like people who are **REALLY** interested in what they are doing. Remember this: if you are my client and do a poor job, it makes me look bad, no matter that it may not be my fault. If you do a great job and have a very successful vineyard, it makes me look good regardless of my role. It is extremely important to my business that you succeed.

Site evaluation is one of the most critical steps in vineyard development. Here is where a soil consultant would be of immense value in determining the physical, chemical and biological nature of your soil so that proper amendments, improvements and rootstock assignments can be made. You only have one chance to do this correctly and in your eagerness to get started you may be tempted to rush through the process. But now is the time to be logical and methodical.

All of us tend to make the same predictable vineyard mistakes when we don't benefit from other people's experience. These mistakes can be costly and enduring. A good consultant's advice will save you the consulting fees for mistakes and much more every year if you develop a strong partnership.

Another option that would greatly ease your way is to hire a vineyard development service. Unfortunately, there are few such services available at the present time in the East. The situation should improve as the regional wine industry expands and offers more opportunities. If you decide to hire out the development work rather than do it yourself with a consultant, take the time to check their references thoroughly. Ultimately you are the one who must judge the quality and live with the results of work that is done for you by a consultant or vineyard development company. This is why having basic knowledge of viticulture is important.

Finally, the best wine growers never stop asking questions and never stop trying to grow a better grape. The moment you do, you will be going backwards in your pursuit of quality.

A Footnote: Wines and Vines

Is it necessary to drink wine to be a good wine grower? If your aim is to achieve the highest quality, the answer is an emphatic 'yes'. In much of the Old World the grape grower and the winemaker are the same person. Information need only cross from one side of the brain to the other. In France there are no separate terms to distinguish the winemaker from the grape grower: a *vigneron* grows the wine from vine to bottle. In the New World, independent vineyards often operate separately from the winery. In this scenario, there is some distance between the grower and the wine. The shrewd grower understands the symbiotic relationship between vine and wine and seeks knowledge in both viticulture and enology that will enhance communication with the winemaker. After all, your objective is to grow the high-quality grapes needed to make specific wines.



[Wine making technical workshop with Brian Wilson from Keystone Cooperage](#)

example, if a red wine is herbaceous and tart, perhaps the fruit was not fully mature when harvested and leaf removal was not carried out properly. Why did this happen, and how can it be

Understanding what constitutes a good wine will help you to define and achieve this goal. If you identify a benchmark – for example, a Burgundy Pinot Noir or a red Bordeaux blend – as the objective for your vineyard, then you can study the details of how it is made, which involves working backward from the wine through the winery to the vineyard. You can then use this knowledge in your vineyard evaluation and development process.

Once wines are made from your grapes, tasting them will provide clues as to what has or has not happened in the vineyard, and valuable lessons can be learned. For

avoided next year? Analyzing backwards from the finished wine to viticulture in the field is an important exercise and helps to push quality forward.

The vineyard and the grapes it produces should have a goal in wine. Benchmark wines are also important because of the subjective nature of wine appreciation. Pinot Noir presents a classic example; some prefer the more delicate and elegant style of a Burgundy, while others insist on the superiority of big, fruit-bomb wines from sun-drenched California. These are two great, but very different styles of Pinot Noir and one could argue forever about their relative merits. However, there is general agreement that a wine with very light, cherry fruit, no mid-palate and a tart finish may be technically correct but cannot be considered a benchmark wine. It constitutes a midpoint along the continuum leading to the great wines. ‘Technically correct’ should be your starting point, the absolute minimum that you are willing to accept for your grapes. A better site, more resources and better viticulture will possibly allow you to achieve a superior wine.

In order to calibrate your palate, you need to taste wines analytically in the company of knowledgeable professionals. Tasting a wide range of wines – local, regional, domestic and international (although you should pay close attention to those that lie within the climatic range of your site) – and discussing them with experts whose palates are more developed than your own will improve your skills in both technical tasting and wine appreciation. This exercise is essential if you want to learn how to connect wines to the vineyard.

Taste wines both with and without food. It is a revelation to drink Eastern wines with food because they, like their European cousins, tend towards more food-friendly acidity and concentration than arid region wines. Understanding the relationship between food and wine on all levels – the sensory, the social and the emotional – will help you to become a better wine grower. Use proper tasting procedures and tools such as the right serving temperature, decanting for red wines, good stemware, and a proper setting.

Wine and viticulture education can be taken a step further into the world of food, dining, service, and sales – what tends to draw people to the vineyard in the first place. While selling a bottle may seem far removed from the activities in the vineyard, they are in fact intimately connected. Growers who can line up their goals with the needs of producers and the preferences of consumers will be better prepared to negotiate the tortuous path from vine to table. This is essential because the economics of growing wine works in reverse – from the consumer opening the bottle with your grapes in it, back through to the winery and what it is willing to pay for your grapes based on the retail price.

In addition to understanding wine and food, you should learn something about the winemaking process. You do not need an enology degree, but understanding the fundamentals will allow you to communicate with winemakers and integrate your practices with their goals. The successful grape grower makes the wine maker’s job easy. A winemaker will be striving to achieve a certain style and his intentions must be translated into actions in the vineyard. You should also be sensitive to each winemaker’s personality. As in every sphere, there are people who will be easy to work with and those who demand a little more effort. You need to figure out how to work together effectively to your mutual benefit and that of the wine.

Chapter 7

Farm Safety

Safety is a subject that is often buried or not even mentioned in agricultural guides, but it may be the most important chapter in this manual to you and your family. Agriculture has always ranked among the most dangerous occupations in America. Every farmer needs to confront this reality and plan and prioritize a strategy for creating a safe working environment. A serious accident, or worst of all a death, can quickly take the joy out of your project. It isn't worth taking the chance.

Never think that an accident couldn't happen to you. This is a dangerous and naïve attitude. Even more important, don't think that it couldn't happen to someone else, including a child. You and others will be working with and around large equipment, power tools, heavy items, electricity, sharp objects, pesticides, and so on, and visitors will also be exposed to these dangers. Tractor roll-over and power take-off accidents are common and need to be guarded against. Every single farm operation should be evaluated from a safety perspective. All safety requirements, rules, regulations, and postings regarding equipment, pesticides, safe re-entry into a field, etc. exist for a reason and should be followed to the letter. Above all, common sense, patience, careful observation, and sound judgment must be applied every minute of every working day.

Safety is the first thing that you should think about each morning before you start. Your local cooperative extension service probably offers workshops in farm safety. If you have kids, please visit "Farm Safety 4 Just Kids" at <http://www.fs4jk.org/>. Google 'farm safety' for further information that, while not specific to vineyards, will still provide helpful tips. It is paramount, especially if you do not have a farming background, to be aware of the safety and health hazards to be found on a farm. Gempler's, Inc. is a company that specializes in farm safety equipment and clothing, so start by visiting their web site and getting a copy of their catalog. Government agencies such as your state's Bureau of Labor and the federal Environmental Protection Agency compile and enforce safety and health regulations that apply both in and around the vineyard. You should be fully apprised of these regulations. Understand the requirements for safety training if you have employees, and go through with it! These laws are enforced and fines can be levied or a business suspended if non-compliance is verified.

Fortunately, grape growing does not have to rely on highly toxic pesticides, but most vineyards use fungicides, insecticides and herbicides. All of these can pose threats to human health and the environment if not properly used. New grape growers frequently make careless mistakes when handling and applying pesticides. They may select the wrong material and apply it at an incorrect rate or too often. Frequently the application device may not be properly calibrated. Calibrating a sprayer is not something you learn in college, nor is it completely intuitive. Find out where you can learn to do it right. It makes no sense to apply expensive materials to your vines if it is not done correctly. Use the proper, label-required personal protective equipment including clothing and other protective devices (goggles, gloves, respirators) to ensure the safe handling and application of pesticides.

All grape growers are strongly encouraged to study for and pass their state's pesticide applicators examination. Most growers will be licensed as private applicators, meaning that they can use approved materials, but only on their own farms. If you don't have a license, you can turn to commercial applicators who contract their work to farms. The safety, proper handling and usage training that you undergo to prepare for the applicators exam will make your farm a

safer place, maximize the effectiveness of your products, and minimize the need for off-farm inputs. All growers, even those who have no hired employees, should be familiar with the EPA worker protection standards, which are designed to protect the health of you and your family, as well as employees. The study materials and examination are prepared by the state Department of Agriculture and can often be obtained at your county extension office.

There are other organizations and agencies that can assist you with safety training and compliance. The Farm Employers Labor Service (FELS) offers safety and compliance materials and services. State agencies such as the Department of Agriculture and the Bureau of Labor should be consulted. Your local agricultural commission and cooperative extension service will also have valuable information and workshops.

When in doubt about any safety-related matter, first STOP, then ASK. Do not let an accident happen just because you were too lazy or too busy to prevent it. Every accident could have been prevented.



Chapter 8

The Economics and Business of Grape Growing: The Hard Truth about Money and Vineyards

Nowadays most people get into the vineyard business simply because they love wine. Many do not stop to consider the economic side of developing and operating a vineyard. It may begin as a hobby and then grow into a business. The usual scenario involves someone who makes surprisingly good wines at home and is encouraged by family and friends, “Hey, you could sell this stuff!” The light bulb blinks on and the snowball starts rolling down the hill.

Before you start, it is important to have a clear understanding of your goals. If your vineyard is part of an estate winery, what style and price point of wine do you expect to produce? If it’s a \$40 Bordeaux red blend, the dynamics will be completely different from making a \$10 Concord or Niagara wine. The \$10 wine will require more productive soils to support higher yields and this should guide site selection, just as a high-priced red wine from a high density vineyard will have its own particular site and cost requirements. If yours is an independent vineyard that will sell grapes to local wineries, the economics are challenging and you must optimize yields without sacrificing quality in order to be financially sustainable. Be aware that the independent vineyard as a self-sustaining business is going the way of the dinosaur. If this is your ambition, you must study the spreadsheet and consult other growers to determine the feasibility of your project. Having a day job that can prop up the business will tip the balance in your favor, as long as that outside income continues to come in.

There is an expression in agriculture that describes two different approaches to farming, those who “farm with money” and those who “farm for money.” In the capital-intensive, new age wine industry there are plenty of the former, but I endorse and advocate for the latter. There may be tax reasons to lose money, but eventually it’s about managing a business and for it to be sustainable it must make money. In our culture when money is at stake, everything is taken much more seriously. A vineyard can turn out to be a bottomless pit financially, and a winery can be even worse. For this reason, it is essential that you do some careful research on the potential costs and cash flows. You can begin with information from economic workbooks and calculators, but nothing can substitute common sense, business savvy, and the advice of those who have already written checks for their own vineyards.

Investigate your vineyard’s economics thoroughly and in detail. Above all, talk to experienced (and preferably profitable) growers. Find a recently established vineyard that is similar in design and goals to your own and get information from the owner regarding the real costs of running his business. The person who writes the checks knows the real costs. Your local wine or grape growers association may be able to provide economic information and the names of growers to contact. The vineyard should be fun, but if it threatens to turn into a financial disaster the joy will quickly disappear.

It isn’t difficult to estimate the main costs of developing a vineyard, and there are excellent calculating tools readily available (see Information Resources). Your development and business plans will necessarily be dynamic documents since it is impossible to anticipate every variable in such a complex process. But you need a plan to guide the way, and you can always make adjustments as you go along. It would probably not be unwise to calculate a budget and then double it to arrive at a fairly realistic project cost.

While it is not essential to have a large amount of capital to start a commercial wine vineyard, the reality is that it certainly helps. No matter what region you find yourself in, there is

a strong correlation between the quality of the wine and the quality of the vineyards and wineries that produced it. Having ample funds available translates into more choices and the leeway to correct your errors. Great wines can spring from all kinds of beginnings in terms of people, places and resources – rich or modest, statement wineries or simple pole barns, and the whole gamut of vineyards from the disease-infested, semi-abandoned site to the perfectly manicured, English-garden style vineyard – but it is easy to throw good money after bad, so pay close attention to the budget from the very outset. *Vinifera* vineyards require the greatest demands on capital, while hybrid and native vineyards tend to be less expensive to develop and maintain.

The site: the biggest up-front expenditure

Fine wine has a better chance to emerge from the well-tended vineyard, but the strength of a site may drive the wines in a rustic vineyard to higher-than-expected quality. Since the most important variable by far in your project will be the vineyard site, you should start by investing in the best one you can find and afford. This will enhance your chances of producing a fine wine in the face of considerable odds, especially in difficult vintages. Vineyards can vary significantly in quality. Some sites are so poor that the vines will never be more than mediocre no matter how much money you throw at them. However, in most cases a vineyard's performance can be improved if the quality of the viticulture applied to it is ambitious. The more flaws a vineyard site has, the more effort and expense will have to be invested to make it perform well, from development to annual operating costs during the life of the vineyard.

Land is almost always the greatest development expense, unless you already own a site; this certainly gives you an advantage, assuming that the site is suitable and will not require expensive modification or applied viticulture to make it viable as a vineyard. These days, when a vineyard industry takes hold in an area, a 'vineyard property' is often more expensive than a similar site without this designation, because the locals think that prospective vineyard owners are wealthy and can pay more for land. Be aware of this bias as you search and discuss land values.

A recent development is the establishment of vineyards as an investment and/or as a hedge against urban development. Because of their relatively high return on investment, vineyards are one of the few agricultural undertakings that make sense in areas with high property values. If you factor in the value added by wine production, they appear to be an even more attractive proposition. Hence there is a trend to sign vineyard property into local conservancy programs in order to preserve America's agriculture and open space heritage.

The scope of this manual does not include a detailed analysis of development and operational costs, but a number of business resources, including vineyard cost calculators, are listed in the Information Resources section. These tools can help you to work out your expenses. Running a few models and comparing the results will give you a good idea of your prospective expenses. You should always do a reality check, however, by consulting experienced local growers.

Growing the most expensive grapes is not always the shortest or surest route to success or profitability. A fertile, deep, flat site may be best suited for development as a 'production' vineyard with larger yields of a high-quality hybrid such as Vidal, suitable for making a good fighting varietal wine with an excellent value-price ratio. In terms of potential farm-gate value, this type of vineyard can be just as profitable as an ultra-premium one, or even more so.

The rest of your budget

Once you know how much you will be investing in the purchase of a site, you should start projecting the remainder of your budget, which will include a bewildering array of elements. The type of vine and the vine density will have a significant impact on development costs; compare, for example, own-rooted Vidal on 10 x 6 spacing (726 vines/acre @ \$2/vine) with Cabernet Sauvignon 337 grafted on Riparia Gloire rootstock on 7 x 3 spacing (2075 vines/acre @ \$3.50/vine). Other development expenses include trellis materials, consulting and professional support, labor for installation and operations, infrastructure (buildings, water, electricity, etc.), equipment (tractor, sprayer, etc.), and apparently optional items (irrigation, drain tiles, deer fence, etc.) that could make the difference between a good wine and great wine in any given vintage. There are absolute essentials, essentials, and elements that are non-essential but desirable in vineyard development, and it will be necessary to determine how long a list your budget can support.

As we noted above, it isn't difficult to set down the broad outlines of a budget. The tricky part is dealing with incidental and unanticipated expenses. The cost of materials can fluctuate dramatically (almost always upwards) and should be monitored throughout the planning process. At the time of this writing, the cost of land, materials (especially steel), labor, equipment, fuel and petroleum-based products, and everything even remotely connected with farming has been skyrocketing. Narrow vineyard tractors are pushing \$40,000. Re-circulating sprayers can run upwards of \$25,000. Add a pick-up truck or some flatbed delivery trucks and it is easy to go over budget. Labor costs for a mature vineyard will make up at least 50% of your operating budget.

Every single purchase – from the vines to the tractor – will involve a decision about whether to get the grade A, B, or C product. Grade A is always preferable because vineyards represent a long-term investment. If buying better equipment and materials threatens to break the budget, then adjust the budget or vineyard size, not the quality of infrastructure. It is always advisable to shop around for the best value but experience indicates that you get what you pay for. Our advice is – Do not shave costs anywhere, just downsize as necessary.

Investing in quality

There are many visual indicators of a serious vineyard effort, such as stout deer fencing and metal training stakes. If an owner is willing to spring for these costs, it means that he understands the necessities of viticulture and the value of his crop. In deciding whether or not to install irrigation and other expensive add-ons, the costs should be analyzed in relation to the ultimate value of the crop in the field, or perhaps the value of the wine. If you look at your budget from this perspective the best approach is to protect your investment through quality control. If you are simply selling your grapes (rather than also making wine), these extra costs may be harder to justify, but remember that intangibles such as your reputation as a wine grower are at stake with every bit of control that you relinquish.

Trickle down vineyard economics

Vineyards are expensive projects to develop and maintain. It's important to have a realistic view of the overall economic demands. First, the type, style and price point of the wine must be determined. The grower-winery owner should be well aware of the presence of a glass ceiling on the price of wines in the East. The ceiling is especially difficult to penetrate for super premium quality wines. Currently, the best red wines are able to command \$40, sometimes up to

\$50 or more. Rare exceptions exist for very limited production wines. Given the harsh financial demands on vineyard development and operations to grow these wines, a careful cost and market analysis should be performed to see if such wines are practical, at least for now. The market for Eastern wines is still evolving and eventually well-heeled consumers may acknowledge their quality by opening their wallets. It is a sensible exercise to work backwards from the targeted bottle price to the recovery costs for the business and the annual operating expenses to see if they can offer a reasonable balance and bottom line. At low yields, especially for high quality red wines, the economics are daunting, even in well-established wine regions. As with every other aspect of this business, the challenge is greater here in the East.

If a great wine is your final objective, then you should consider how wines are rated, for example by the 100-point rating systems of *The Wine Advocate* or *The Wine Spectator*, and how scores may impact bottle price. Good wines in the 80-89 point range command a reasonable price, but a disproportionately large effort and expense is required to achieve a score of 90 and every single point above this threshold. At the same time, your ROI could increase significantly as your wine climbs the point scale, motivating you to go the extra distance for quality. There are specific vineyards in the East that can help as models for this type of vineyard project.

Marketing

Many new growers do not seriously consider how they will market their grapes until the moment arrives to sell them. It takes a while, but the grapes will arrive and they need to find a home in a tank or barrel. You may still be a few years away from selling grapes, but it is not too early to start thinking about who will be buying your grapes and/or wines. Marketing wine grapes must begin with a good, hard look at a map of the wineries in your state and in the surrounding region: these are your potential customers. Find out what wines they are making and successfully selling and how you might fit into their grape portfolio and business plan.

In the East, wine is mostly a local, small-business industry, and almost all wine is sold at full retail from tasting room outlets. This arrangement offers great advantages up to a certain size of business. Because sales are mostly retail, the winery retains the full value of its product. This provides an economic advantage over those in the wholesale market, who may be selling at only half of full value. In the West, wineries rely on a three-tiered wholesale market and make about 50 cents on the dollar. In the Pennsylvania state stores, the markdown is also about 50% on local wines. Therefore only the bigger wineries can afford to enter the wholesale and out-of-state markets, and in the East they have done so with only limited success (this is one reason why wine drinkers have the impression that wine is only produced in California, Oregon and Washington).

Wherever your vineyard is located, you must consider who will be buying your wine and what their preferences are. The wine market can be roughly divided into two sectors – sweet and dry – with dry wine aficionados tending to live in the city and sweet wine enthusiasts in rural areas. A generalization often borne out in tasting rooms in the East is that people will “talk dry and drink sweet”. Red wines usually sell for more than whites, but white wines are processed more quickly and can alleviate cash flow problems. Indeed, in many wine regions the high-end wines are propped up by the semi-sweet and sweet, value-priced wines. A market-savvy grower on Long Island claims that the varietal distribution with the best return is 75% to 80% reds and 20% to 25% whites. You, however, must seek the best possible balance based on local market conditions. Only a few Eastern wineries specialize in all or mostly *vinifera* (dry) wines and they tend to supply niche markets, usually close to a large city.

Figures Intended to Scare You: the approximate cost to plant one acre of *vinifera* grapevine vineyard in Southeast Pennsylvania in 2011

Assumptions: Start with a square one-acre, cleared field. Spacing is 8' x 4' (1361 plants per acre), vertical shoot position (VSP) trellis. Dimensions of field are 210 ft x 210 ft (27 rows).

1.	54 x 10' Rib-Bak End Post	1575
2.	297 x 8' - 10g notched galvanized steel line stakes	2896
3.	5,700' 12 gauge hi-tensile trellis wire (\$ 0.024/foot)	137
4.	54 - 36 inch earth anchors	402
5.	29,000' 14 gauge H/T 4-life wire (2-pair catch + 1 irrigation)	464
6.	500' braided end assembly wires	468
7.	110 wire vise	176
8.	54 wire strainers plus handle	143
9.	Nicopress tool and sleeves	100
10.	1100 pencil training stakes	660
11.	Gripple wire fasteners	220
12.	Vine ties	200
13.	1100 x grow tubes (or milk cartons)	803
14.	1361 x grafted <i>vinifera</i> grapevines (prep and shipping)	5444
15.	Labor at \$15.00 per hour x 120 hours (planting, trellis, training, etc)	1800
16.	Laser planting (\$45/row + \$.60/vine + \$1800 truck fee)	3800
17.	Irrigation (not including development of water source)	7000*
18.	Site preparation (soil preparation, soil amendments, weed control, etc.)	1000
19.	Deer fence (8' high tensile exclusion, 1 gate, 4 corners)	2500*
20.	Drain tile (soil assessment will determine if it is needed)	2500
21.	Beer	100

TOTAL DEVELOPMENT INVESTMENT: \$ 32,388

Items 15 and 16 will vary depending on labor for planting or a laser planter. The truck fee may be shared with other vineyards in the area using the laser planting service. This is a rough approximation of costs. It will vary greatly based on current prices, vineyard design, options and many other unpredictable variables. For example, wider vine spacing will reduce vine numbers and a divided canopy may or may not reduce trellis costs. However, in this scenario, it would not be unwise to add 25% to this cost for inflation, incidental and the unexpected. In general, the more demanding the site, the higher the development costs will be. Flat square fields are the easiest/cheapest. Steep, rocky, fields with uneven blocks are the most expensive. French hybrid vineyards are generally less expensive to develop than *vinifera*. A deer fence is no longer considered optional for a high quality vineyard. Drain tile will depend on soil evaluation. Drip irrigation is highly recommended. Developing a water source can be very costly, as can utility development costs.

Necessary equipment and tools for new vineyards:

1. Tractor
2. Cultivator
3. Fungicide sprayer
4. Herbicide sprayer
5. Vine hedger
6. Flail mower
7. Pickup truck
8. Post pounder and/or auger
9. Hand tools
10. Supplies
11. Storage shed

Prices provided by Michael Schmidt of Spec Trellising, Ivyland, PA. <http://www.spectrellising.com/>

* Cost estimates provide by Nelson Stewart at Karamoor Farm Vineyard

Try to identify the varieties needed by wineries. Begin by looking at what your neighbor grows and manages to sell. If there are no vineyards nearby, then do the necessary research to determine what varieties have the best market potential. Ideally, in a given region a consensus between viticulture, marketing and personal taste will form and a single varietal wine, such as Pinot Noir in Burgundy or Nebbiolo in Piedmont, will emerge. The Eastern wine industry has a regional identity of sweet native and hybrid wines. The classic dry wines still need to be established; after nearly forty years of modern wine growing in the mid-Atlantic region, a definitive choice of red or white varieties has not yet been made. This may be regarded as either positive or negative. Some consumers revel in the diversity of flavors and styles available to wine lovers in the East, but those seeking to establish a reputation for the East on the world wine map realize that this can only be done with certain noble *vinifera* varieties.

The vagaries of taste are another problem that you will face in this business. The aftermath to the airing of “The French Paradox” on the television program *60 Minutes* presents a striking case in point. This episode discussed the thesis that the consumption of red wine by the French might be helping to offset the negative effects of their high cholesterol diet. After the show was broadcast, the market flipped from 2/3 white and 1/3 red to the opposite almost overnight.

The best and easiest solution is to work with an estate winery, where you simply hand the grapes off to them. Independent vineyards should strive to develop a broad, reliable and long-term customer base. One sure-fire formula is to grow high-quality grapes and negotiate the highest possible prices for them. In all but the most saturated markets, outstanding grapes will always be in demand and winemakers have a sixth sense as to which vineyards grow the best grapes. When developing a marketing plan, you must also take into account how far your grapes or wines will have to travel to get to their markets. You certainly want to keep your transportation and shipping costs to an absolute minimum.

All of these considerations must be taken into account in your decision regarding what varieties to plant. It is by no means too early to determine who your customers will be and what varieties, clones and wine styles are in demand. These market realities should then be balanced against the viticulture requirements of the site and your own goals for the vineyard. Remember that your grapes or wine must be sold at a price that can support the quality of viticulture required to produce that wine.

If grapes are in short supply in your region, one option worth exploring is to make arrangements with local wineries to plant the varieties they need and share the development costs. A winery might, for example, pay for the vines in exchange for a multiple-year assurance of access to the fruit. This will create a relationship of close interdependence so reflect carefully before you make any such agreement.

The dollars and cents of development costs

The costs of establishing a vineyard will vary depending on land prices, site challenges, vine density, labor, trellis and equipment costs, and a myriad of other, often unpredictable expenses. For a hybrid vineyard, expect to spend about \$5,000 to \$10,000 per acre in development costs. For a top-quality *vinifera* vineyard, one of our growers says that the minimum development cost is \$15,000 per acre (not including land, irrigation, deer fence or drain tile) and high-density vineyards may exceed \$25,000 per acre. This is the investment required to make a vineyard appear on a piece of property, including materials, labor and services. High quality consulting services may add significantly to the overall cost.

It may be a practical and helpful exercise to work backwards from the expected grape or estate wine prices to determine how feasible an economic model is for your vineyard. The economics of a vineyard requires something that goes against the grain in our current culture, i.e. a long-term perspective. Most development expense models predict an ROI horizon of 7-12 years for high quality *vinifera* grapes, less for hybrids. If a winery is involved, it pushes out even further. This will test the financial patience of even the most stalwart grower, who will have to take the long investment view that the vineyard will give back much more than just financial rewards, and will eventually be passed on to the next generation.

Size was discussed earlier in terms how much vineyard can be afforded, there is also the question of what size can be managed? The general rule is that one person can manage five acres full-time, or two to three acres part-time. Above ten acres you are going to need some experienced full-time help. How many acres will support a family of four? Take a 10-acre Chardonnay vineyard; at 2007 grape prices of \$1300/ton x 4 tons/acre, it would have yielded a gross revenue of \$5200/acre. Deduct \$2500 to \$3000 for operating expenses and then multiply by the number of acres you need to sustain your current lifestyle. It's here that the day job shows its value and the unquantifiable value-added allure of wine enters the picture.

As a grower, understanding the relationship between bottle and grape prices may help to nurture a better business relationship between vineyard and winery. In the 1950s, the Christian Brothers Winery and later Robert Mondavi adopted a 100 times bottle price formula for the cost of a ton of grapes, i.e. the grapes that go into a \$10 bottle of Chardonnay should be valued at \$1000 per ton. This formula is still widely used as a measure for setting fair prices between growers and wineries.

To set up or not to set up a winery

Numbers like these explain why many growers eventually become winery owners. With stagnant grape prices, constantly rising costs, and the difficulty of cutting fat and achieving greater efficiencies, it is becoming increasingly difficult to justify the economics of growing grapes alone. Real profitability lies in the value-added wine product. However, this is not sufficient reason to start a winery and the decision to do so should not be driven by economic necessity. Wineries are even more expensive to build than vineyards, and selling wine will take you into a completely different business. The better you understand the economics of both grape growing and wine making, the less you will be tempted to take unwise risks.

The economics of a vineyard are worked out in reverse based on the FOB price of the bottle, because the bottom line is determined by wine sales, whether you are selling your grapes or form part of an estate winery. In your budget analysis you should establish your price points, because the price point difference between two bottles, one with a Parker score of 95 and the other with a score of 90, may be considerable, and your vineyard must be designed according to the standards you wish to achieve.

Many owners do not consider having a winery at the outset, or plan to add one later on. Financial pressures may then push them to construct a winery before the business is ready. However, the buildings, equipment, and facilities can be prohibitively expensive, and some of it (such as the press and storage containers) will only be used for short periods during the year. Then, after the wine is bottled it must be sold. The wine market is global and extremely competitive and a winery owner has to be ready to produce wines of very high quality in order to succeed. Starting a winery should be a very deliberate decision, approached with extreme

Why Do I Need a Business Plan?

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It is commonly thought among operating business owners that a formal business plan is not needed. Some may think that a business plan is only necessary, if at all, for start-up firms or when major investment makes it necessary to obtain capital from a lender or an outside investor. Certainly business plans are extremely useful, even essential for start-ups and major expansion to communicate clearly with bankers, financial advisors, and/or potential outside investors. But does an existing firm need a business plan?

Three events usually push managers into thinking about a business plan: a crisis, an opportunity, or a potential funding source. Rapid changes in the business environment in floriculture are occurring that place many existing firms in a precarious position with regard to their future viability – i.e., a crisis. Just to mention a few, concentration in the retailing, wholesaling, and producing sectors, higher energy costs, increased competition from imports (at the time of this writing it is largely fueled by the currently strong US dollar), and changing consumer demand, have caused previously profitable businesses to feel the pinch of the cost-price squeeze. It is apparent to many that “business as usual” will not suffice for our floriculture businesses.

So how should an existing firm that is feeling the pinch approach change? Business planning is essential! Whether the plan is a written one is not the crucial point, although I would suggest that the discipline involved in having management think through the elements of a business plan, write it down on paper, and ask for input from financial advisors or others from whom advice is routinely sought, is the best process for coming up with a coherent business strategy. Development of a full-blown plan may at first seem overwhelming. It can be approached by first treating the plan as an internal document and a work in progress that is presented in brief outline form with bullet points and a list of questions to stimulate further thinking by the management team. This will break the planning down into a process that will eventually develop into a complete document.

According to Deborah Streeter (the Bruce F. Failing Professor of Personal Enterprise and Small Business Management at Cornell), a business plan is not just a document, it is a state of mind. To put it in the simplest terms, a business plan must demonstrate convincingly that:

- You have the management team to make this idea (new investment, new direction, innovation, new product niche, new distribution channel) a reality;
- Your firm can compete over the long term because of your strengths;
- Your strategy is ideally suited to take advantage of a verifiable market opportunity;
- You know how to manage cash flow, profits, and growth.

When I meet with floriculture audiences, I sometimes ask the marketing question: What is the reason that your customers should buy your products? The answer I get, invariably, is: Because I produce better quality plants than my competitors. Two things are wrong with this answer. The first is that for many firms, it is simply not true! The second is that not everyone can compete on quality. In today’s marketplace, quality is an expectation of customers and is no longer sufficient to differentiate your products from your competitors’ products! More creative and diverse marketing approaches are needed for floriculture firms to succeed in today’s environment. Marketing is just one component of a coherent business strategy, but this example is illustrative of the need for innovation in the industry.

Business planning is an essential starting point for floriculture managers who want to survive and attain profitability and growth in the future. While the main symptom may appear to be a cash flow problem, managers should be cautioned that tinkering around the edges (extending loan terms, refinancing, etc.) may not be a solution. In many situations, a fundamental strategic change is necessary to make the business viable for the long haul.

A good online resource for developing a business plan can be found at <http://www.bizplanit.com>.

caution, and certainly not taken as a quick way out of a financial corner if your vineyard is not profitable or you cannot sell your grapes.

Starting a winery as an afterthought often results in the vineyard becoming the poor stepchild of the business and a victim of “winery disease.” Resources including time, money and attention will inevitably be channeled to the winery, and the vineyard – despite its importance to the success of the entire enterprise – will take a backseat to the more romantic business of making and selling wine. Beware of this syndrome – the vineyard must be treated as an equal, if not more valuable partner in the wine production stream.

Running a business

Business considerations are not usually what motivate a person to get into grape growing, but they are absolutely crucial to the success of the enterprise. Having a detailed business and development plan in place from the beginning makes the same sense for a vineyard as it does for any other business enterprise. It provides a map to evaluate costs relative to progress as the vineyard moves through the development process. Large or small, the goal should be to produce a high-quality product. Professionals in the industry have grown weary of growers who treat the vineyard as a hobby and grow only mediocre fruit. Some may go into the business for the tax write-off, but this necessity is rarely long-term and eventually the sheer weight of the investment will be felt by even the plumpest wallet. It isn't hard to be passionate about the vineyard but also treat it as a business. If you do so, you and others will take it more seriously.

One of the benefits of this approach will be better recordkeeping. Many aspects of running a vineyard – from keeping track of the plant material to climate data, harvest measurements, yield records, etc. – depend on accurate and methodical recordkeeping. If something happens to affect the crop, an insurance company will request the historic harvest yield records. As more government regulations are imposed in the area of agriculture, it is important to keep detailed records of the vineyard's activities, including pesticide and fertilizer use. Employers are increasingly expected to collect employment and payroll information.

The golden rule for a new vineyard is to start small, focus on quality, and grow into the project. The first full grape crop may be 3 to 4 years away and the wine another 1 to 2 years. Recouping the initial investment is therefore at least 7 to 10 or more years away. Patience and good financial planning are crucial to survive the lean early years.

A helping hand financially

There is a saying in the wine industry that in order to make a small fortune you must start with a large one. There is some truth to this, but not everyone with a passion for wine has a fortune to invest. For those who do not, there are a few sources of credit that they can turn to.

The loan and grant opportunities in agriculture are similar to those for most small businesses. There are banks and credit associations such as Farm Credit that specialize in agricultural loans. It would be wise to seek out a lender with agricultural experience, because he or she understands the particular challenges that face farmers.

State and federal agencies are very interested in developing the economies of rural areas and there are some grants and low-interest loans available for farms. Such grants are usually quite specific in their terms, so make sure that any you apply for are tailored to your needs. Contact your state Department of Agriculture or your county's USDA Farm Service for details regarding such opportunities.

As always, you can turn to your regional growers association and experienced vineyard owners for advice and information. In Maryland, to encourage vineyard expansion and meet the growing demand for wine grapes in the state, the wine industry in conjunction with the Department of Agriculture is offering a vineyard planting subsidy designed to assist new growers with development costs. Tobacco settlement funds are helping wine growers in states like Kentucky and North Carolina. Find out about such programs from your local wine or vineyard association.

A final note

So you have decided that you want to plant a vineyard, the family is on board, the accountant has seen the business plan and is skeptical but it's your money, and of course you want to start drinking your wine yesterday. This is where some real discipline must enter into the process. Vineyards, particularly the successful ones, are long-term endeavors.

This manual sets out the timeline for a comprehensive development process. If all goes well, in 6 to 18 months a vineyard will be in the ground. But, depending on when you began turning your ideas into action, it could take longer. The key is not to rush things during the critical evaluation phase. There are far too many decisions that will have long-term consequences. If you make sound choices now, you should have fine wine for decades. If you take shortcuts, then you'll experience frustration and incur extra expenses and your wine may not be as good as it could be. Now is the time for well-planned, methodical progress.

A few words of wisdom from some experienced wine growers in the industry:

- Do not quit your day job, yet (the same holds for your spouse).
- Treat your vineyard like a business, not a hobby or toy.
- Estimate your development costs and then double them. Be pleasantly surprised if you meet or beat your budget.
- Start small and grow into the business, with a modular plan to guide vineyard expansion.
- Quality always trumps quantity.
- Do not skimp on quality materials or methods and do not take short cuts.
- Have fun. Remember why you wanted to have a vineyard in the first place.

An alternative view on starting vineyard size from Ed Boyce at Black Ankle Vineyard in Maryland:

"I disagree about starting small. Small just means you are locked into a money-losing enterprise, because the economies of scale in a vineyard are huge. The only people who should start small are very rich people who want to experiment first so when they do it big they can get it right; in that case I'd advise hiring a vineyard consultant and a really good winemaking consultant and skip the experimenting. I think our focus on small vineyards is killing us. If someone can't start big (10 acres or more), then don't start. Plus, if you start big, you have no choice but to treat it like a business (employees, etc.) and not a hobby."

Chapter 9

Important Viticulture Concepts and Principles

Growing wine grapes is a goal-oriented endeavor. It is important to define your objectives and then develop strategies to reach them based on an understanding of the underlying issues. Throughout the process, first and foremost you should be asking why something is being done, as well as the what, how and when. Good growers are always checking their motives and logic by asking ‘why’ any particular decision is made. For example, why should a steel stake be preferred over treated wood? Is it because of durability, availability, cost, or ease of installation? Why is 8’ x 4’ spacing preferred over 9’ x 5’ and does it really make a difference? This is a business where the pros and cons of every aspect of viticulture and vineyard development must be weighed, and the best option chosen based on the results of your site evaluation.

Wine by its very nature and history is steeped in tradition. A lot of wine mythology is in service to the romantic, cultural importance of the beverage. On the production side, it’s important to realize that traditional practices exist for a reason and most have stood the test of time. Over the past five decades in the New World technology has allowed wine quality to close the quality gap with old world producers. But technology can only take a wine so far up the quality scale and eventually traditional methods must be blended back to bring an artisan quality to a wine. The proportion of new and old methods depends on the type of wine being produced and the best growers consider all of their viticultural options. New growers should be aware of the influence of tradition on viticulture and not subscribe to an idea or practice just because “that’s the way it has always been done” or because that’s how the neighbor does it. Basic viticulture adheres to the same principles in most wine regions in the world but it is up to the individual grower to learn what technology and practices are best suited for any vineyard site to make it perform to its full potential.

A vineyard should be located, planned and designed to achieve the highest quality that conditions will allow, and most properly designed vineyards do in fact perform well under ideal vintage conditions. It is the less than ideal vintages that put a vineyard to the test and the best vineyards will show their strengths when challenged by sub-optimal conditions. Given the realities of rainfall, humidity, frost, and winter temperatures in the East every site has plenty of opportunities to shine or fail. Identify the problems posed by your area and site, design your vineyard to meet these challenges, and your vines will be more consistent producers of high-quality wines.

Site selection and favorable soil and climate properties can make all the difference. Seek out any advantages that will mitigate the known challenges to quality of the region; these include well-drained soils, rain shadows, open fields (for cross breezes), and favorable slopes, aspect, and elevation. Optimizing these factors can increase the chances that a fine wine will be produced even in a difficult vintage. Good places to grow wine grapes may range from a shale soil on a southwest slope in the Lehigh Valley to a rocky soil in the orchard-covered hills of Adams County; wine growers must find such sites and exploit them to their maximum potential.

The balanced vine

Vines exist in all sizes, shapes, colors and conditions. Within certain generally accepted parameters, the viticultural goal is to achieve a balanced vine with a specific size and shape. Should it be a vine that is only allowed to grow waist high, as they do in Bordeaux, or one that is trained over your head on a pergola, as in some areas in Italy or Spain?

In its essence, viticulture is something growers should not want to practice. If a utopian vine in perfect balance is considered, it requires no manipulation to achieve its ideal form and fruit quality. Much of viticulture is the band-aid that growers apply to a vine that is outside of these utopian boundaries. The amount of intervention required is usually inversely proportional to the flaws of the site, or failure to design a vineyard appropriate to the site. So the better the site, appropriate to wine goals, the less work and inputs will have to be made to produce ideal fruit. A good site, like a good vintage, makes making wine almost easy and fun! It makes sense to aggressively and intelligently pursue a good vineyard site for almost every conceivable business and viticultural reason. Unfortunately, for just as many reasons, few growers do.

Dr. Alan Lakso, plant physiologist at Cornell University, writes, “A properly balanced vine has adequate vine growth to provide appropriate vine capacity to ripen the crop, develop fruitful buds for the following year and develop appropriate reserves.” Whether big, medium or small, we want the vine to be in balance, which in winegrowing means a vine whose vegetative (superstructure and canopy) and reproductive (fruit) features are in equilibrium. A balanced vine will require less manipulation to achieve your wine style goals and under proper conditions will yield fully mature fruit at harvest.

Having an idea of the vine shapes and sizes you want will help you to make better wine. A good exercise is to take your viticultural objectives and then try to imagine a perfect vine on your site. Will it be a “big” vine that produces 10 or 20 pounds of fruit or a smaller one producing 2 to 3 pounds? How much space will it need and what would be the best training and trellis system? A perfect vine has just enough space on the trellis to spread out, filling it completely but not infringing on its neighbor’s space; shoots that will grow to the top of the canopy and stop growing around veraison; and just enough fruit set so that thinning is not necessary but all the fruit gets fully ripe. With a picture of the ideal vine on your site, many of the design features necessary to achieve this will come into clearer focus.

One of your early challenges will be to predict vine size before the vine is planted. In some regions this is easy to do just by looking at your neighbor’s vines. But in most of the East, with a few exceptions like Long Island, vineyards are too far apart to learn from a neighbor. In a new wine region, site assessment will be an important part of the discovery process. Think of the soil as an engine with a finite amount of kinetic energy (fertility) waiting to be released through the vine. Water and nutrients are the fuels that drive growth. If it’s a supercharged V-12 you’ll have a big vine, but if it’s a four-banger you get a smaller vine. One visual example is a Thompson Seedless vine on 12’ x 8’ spacing in the Central Valley of California versus a Chardonnay vine on 3’ x 3’ in the Cote d’Or. Why does one vine require 100 ft² and the other only 10 ft² and is one better than the other? Not in the eyes of their growers. Each is ideally adapted to its terroir and wine style objectives. The goal is to have a balanced vine, no matter what its size. In addition, growers should strive for a healthy and productive vine, which does not necessarily mean a big one. A small vine on depleted soils can be healthy despite the fact that it must work harder to access water and nutrients. To a large degree, the site will dictate your decision, but there are also tools that can be used to manipulate the vine’s structure and performance.

There are numerical indices of vine balance (shoot length and diameter, inter-node length, shoot distribution, lateral length, etc.; see Dr. Richard Smart in *Sunlight into Wine*), although these are difficult to apply to young vines. They can be applied to the mature vineyard and offer proof of balance, but an experienced viticulturist need only to step back and look at vines at veraison to gauge the balance in the quality of the canopy and the crop on the vine. Vine

physiologists measure balance as an ideal ratio of 12-15 cm² of leaf surface area per gram of fruit on a vine. This is a difficult formula for a grower to visualize. Balance to an experienced grower is best viewed in a three dimensional canopy and accurate crop estimate at veraison. These are difficult concepts for the novice wine grower to understand but critical parameters must be determined in order to design and work towards vine balance.



Big vine: old California sprawl system in Napa



At Robert Mondavi, crew foreman Juan Martinez among the small vines, close spacing in Carneros

Working with the terroir

Whatever the size and shape of the vine, we are trying to achieve harmony between the vine and its environment. It is a complex phenomenon, but what can be said with certainty is that every vineyard has its own terroir, whether good, bad or indifferent, and the terroir will leave its imprint on the wine. Each grower must strive to obtain, understand, and then to cultivate and preserve good terroir.

You can harness the terroir of your vineyard to your best advantage by making intelligent choices. For example, it is difficult to manipulate the soil conditions, but you can choose a particular soil to plant your vines depending on the style and type of wine you are aiming for. You cannot influence the macroclimate, but you can pick a warmer or cooler site and optimize the conditions to some degree by selecting the best elevation, aspect and amount of slope. The variety, clone and rootstock, and the quality of your vine materials are other factors that will interact with your terroir. Finally, viticulture is your personal input into the system, your footprint in the vineyard and your fingerprints on the wine. Among all these components, which is the most important? One of our most experienced wine growers said that, if forced to choose, he would rather have outstanding viticulture than an outstanding site. As an industry, much more is known about viticulture than site selection, although that will certainly change over time. Small artisan producers known as *garagistes* (garage wine makers) in Bordeaux have demonstrated the importance of viticulture, taking hitherto unappreciated properties and squeezing surprisingly fine wines from them using rigorous viticultural practices. At this time in the evolution of the Eastern wine industry, the best sites have not yet been identified, so viticulture is necessarily the most important factor in the terroir equation.

Vine Physiology and Grape Quality

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For most agricultural crops, growers are looking to maximize yields or dry matter production on a per hectare basis. This is not necessarily the case in viticulture, when one intends to grow high quality wines. Vines can easily yield 30 tons of grapes per hectare. Around the world in vineyards producing high quality wines, yields are often closer to 10 T / ha, sometimes even lower. Producing about three times less than you could is not necessarily economic nonsense in wine production, because in no other crop is quality so well paid for as in viticulture. The price of a kilogram of grapes can easily range from \$0.50 to \$5 depending on its potential for producing quality wines.

Wine quality is generally optimized when vines meet some sort of stress, particularly for the production of red wines. The stress that is most frequently met in vineyards is water deficit stress. Water deficit stress can occur in dry farmed vineyards, but also in irrigated vineyards where water can be withheld in some part of the season to enhance quality potential. How is it possible that water-stressed vines produce better wines than unstressed vines? Water stress profoundly modifies vine physiology. Some of these modifications have negative consequences for quality potential, while others have positive ones. Water stress reduces photosynthesis, i.e. the transformation of CO₂ into sugar in the chloroplasts that are mainly located in the leaf blades. Hence, dry matter production is reduced with negative implications on yield. However, water stress also provokes shoot growth cessation, reduces berry size and enhances the synthesis of polyphenols. When shoot growth stops before veraison, a greater percentage of the sugar produced by photosynthesis is available for the ripening of the berries. When berries are small, a smaller amount of sugar is needed to increase the concentration of sugar in the grape juice. Polyphenols are quality components in red wine production, even more so than sugars. Finally, when water deficit stress is moderate the positive effects (shoot growth cessation, small berries, polyphenol synthesis) outweigh the negative effects (reduction of photosynthesis). Thus, quality potential is enhanced.

This mechanism explains why in the Old World, soils with high quality potential for red wine production are soils with moderate to low soil water-holding capacity, because they are shallow or stony. In the New World, where vineyards are often planted in very dry climates, irrigation is in most cases used to obtain economically sustainable yields. However, in these regions great improvements in quality have been obtained over the last decade by implementation of the concept of deficit irrigation.

When the climate is rainy, or when soils have a very high water holding capacity, it is sometimes virtually impossible to obtain water deficit, even without any irrigation. In these situations growers can successfully produce white wines. Grapes for high quality white wines are better if they contain few polyphenols, and water deficit stress is not as crucial as it is in red wine production. It can even be detrimental to quality because it provokes aroma losses. If a grower intends to produce a high quality red wine in a situation where water deficit stress is not easily attained, he can look for another sort of stress. Limited nitrogen availability has similar effects to water deficit stress: reduction in shoot growth (rarely total inhibition), reduction of berry size, and enhancement of polyphenol synthesis. Nitrogen supply to the vines can be limited by not fertilizing in any way (mineral or organic). If the soil is rich, this may not be enough. In this case a cover crop can create competition for nitrogen with the vines. This competition can be more or less severe depending on the species of plant used.

At Château Cheval Blanc (Premier Grand Cru Classé, Saint-Emilion, Bordeaux, France) the best soils have low water-holding capacity and the best vintages are dry. These are conditions that enhance water deficit stress. In deeper soils, where more water is available to the vines, grass is grown in the inter-row to reduce the nitrogen uptake of vines. These vineyard management practices have been found to be very successful in improving quality.

row to reduce the nitrogen uptake of vines. These vineyard management practices have been found to be very successful in improving quality.

The synthesis of all the components of terroir – soil characteristics, amount and distribution of rainfall, quality of sunlight, length of days, cold winter temperatures and late and early frost events, plant genetics, pruning, canopy management, yield regulation – will all find expression in vine balance. The challenge is to predict how size and balance can be achieved in a particular terroir.

Stressing your vines

If you pay close attention to vintage quality in Europe and other non-arid regions, you will observe a relationship between the weather in a particular vintage and the quality of the wines. As a general rule, warm, dry years produce very fine wines whereas cool, wet years produce lesser quality wines. While the correlation is not so simple and absolute, we know that exposing the vine to mild stress is a useful practice, particularly for the red varieties, and should be taken into account in the planning and design of any vineyard. The goal is to regulate the amount of moisture in the effective rooting zone of the vine at key times during the growing season.

The underlying biology is simple. Water, nutrients and sunlight are the fuels that power the vine. If any of these is lacking, vine productivity will suffer. However, if they are in excess the vines may become too vigorous and wine quality can suffer. Once again, this shows why balance and harmony make better wines. In nature a vine's sole duty is to survive and if necessary, disperse its seeds. If you have ever taken a walk in the woods and seen a native vine, you know it can grow vigorously, developing a large trunk and climbing high into the tree canopy. A vine's vegetative imperative will be expressed if it has sufficient sun, water and nutrients to satisfy its basic needs. Under these conditions, however, its reproductive nature and the production of fruit become secondary. Only when the vine feels threatened will its reproductive need come into focus and direct resources toward seed production. The goal of producing ripe fruit is to attract a bird or other creature, which will eat the berry and deposit the seeds where they can grow and ensure the perpetuation of the species.

Therefore, the vine's desires may be at odds with our wine making goals, which are to have very ripe grapes every year, even when the vine is feeling comfortable and stress-free. How to induce the vine to change its physiological behavior is one of the great challenges of growing wine in a wet climate. In California and other arid regions the solution is simple: to stress a vine into the reproductive mode the vineyard manager can just flip a switch and withhold irrigation water. Almost immediately the vine will sense the lack of water and produce a biochemical signal. In response, resources will be diverted from producing more leaves to ripening its seeds. This is what we want as wine growers!

There are certain times in the growing season when mild water stress is desirable. Shortly after fruit set to limit berry size and just before and after veraison to help push fruit ripening. Not so much stress that the vine wilts or photosynthesis is hampered, but enough to slow growth (which can be seen in the slowing or termination of shoot growth). Unfortunately, the Eastern U.S. receives even more rainfall, and the possibility of hurricanes and low pressure systems during the critical months of September and October than regions with a similar climate such as Bordeaux and Burgundy.

Growers should try to understand the relationship between the soil, water and the vine in order to regulate growth, particularly during the most critical periods. There is a delicate balance to be maintained, because the notion that vines must 'suffer' to produce good fruit is not a hard-

and-fast rule and exaggerated in the popular wine media. There are times during the growing season when mild water stress will help to regulate berry size and hasten fruit maturity, but vines should never be nutrient and-or water deficient.

Uniformity and synchronicity

Along with vine size and balance, uniformity and synchronicity are key goals in viticulture – within and between vines and even down to the individual berries in a cluster. In the simplest terms, winemakers want uniform fruit with the same optimal maturity parameters in every berry. Achieving uniformity, however, is a terrific challenge. You may work to attain vine balance, but uniformity is also influenced by a myriad of site characteristics. A non-uniform vineyard may have a variety of different soils, or the victim of severe winter injury, trunk diseases or viruses resulting in missing vines and variable vine size, or it may simply be poorly designed and-or managed. It is not unusual to see vineyards in the East with relatively large areas of missing or replanted vines. Vines of different ages never ripen at the same rate, which increases variability and open trellis is uneconomical. A consistently uniform vineyard is more difficult to achieve in Eastern growing conditions than more accommodating climates.

A uniform vineyard is a pleasure to see. Building uniformity in the vineyard means developing “sameness” in all aspects of the vineyard, but this does not imply eliminating the distinctive characteristics of a site. It should be noted that there are fine wine growers who believe that non-uniformity, to a degree, will contribute to the complexity of a wine and, in fact, is what makes individual wines unique. Certainly there are differences among terroirs. The quest for uniformity generally resides within a defined zone of terroir. But this is certainly a topic that is subject to debate and different viticultural approaches.

Your goal is to produce fruit of uniform ripeness along all parts of the vine and within the separate sections (defined by the variety, clone, rootstock, or other terroir features) of the vineyard. In a perfect world every grape in a block of vines would ripen to the same brix level but berries at the bottom of the cluster will ripen faster than those at the top, and clusters on the north or east side of a vine will ripen more slowly than those with a southern or western exposure. This variability makes winemaking more complicated because acid, pH, flavors, phenolics and other quality components become jumbled. It also makes the task of accurately sampling vineyards more difficult. On the other hand, a fine line must be drawn on the matter of uniformity, because we want to celebrate the differences and uniqueness of terroir and not homogenize it.

Uniformity may exist in consistent and regular soil and climate features across a vineyard site. These are often the easiest and most predictable vineyards to farm and make wine. Once variability is introduced, only careful site evaluation use precision viticulture tools and technologies, can help to build greater uniformity into a site. Once the vineyard is planted, viticultural practices can be used to enhance uniformity.

Uniformity is prized in specific blocks where a defined style of wine is expected. Of course, there will be variability as the mesoclimate, the soil, and the microclimate of individual vines shifts across a vineyard. These factors all go into defining the terroir. Achieving uniformity begins with careful site analysis and vineyard design. After the vines are planted, practices such as training and pruning can be employed to create vine uniformity. Viticulture tools such as rootstocks, training systems, artificial drainage, irrigation, etc. can enhance the uniformity between sections of the vineyard. Precision viticulture makes use of a variety of tools to analyze, define and develop uniformity in a vineyard, including sophisticated soil pit and

electromagnetic induction analysis, geographic positioning systems (GPS), geographic information systems (GIS) for mapping purposes, aerial photography and more. These are all technologies that you might consider using in the evaluation process.

Ideally, once uniformity is achieved then synchronicity will follow. This means that each physiological process, such as flowering, veraison, and fruit ripening, will unfold across a vineyard or a block of vines at the same time, leading to even results. Bud break that takes place synchronously in a block of vines holds out the promise that the fruit will reach maturity at the same time. Within clusters berries that ripen together usually leads to better wines. Wide variations in ripeness between berries, clusters, vines, or blocks of vines can reduce the quality of the wine. Nevertheless, you will have to face the fact that the cooler the site, the more difficult it is to achieve consistent synchronicity of ripening.



Synchronous and uniform ripening of Pinot Noir on the Niagara Peninsula of Ontario: it's not by accident

Powering the vineyard: sunlight and nutrients

The role of light and temperature in all vine physiological processes, and especially in fruit maturation cannot be overestimated. This is a top consideration in choosing a site and designing a vineyard. Sunlight powers photosynthesis and the production of sugars and carbohydrates, which are essential ingredients in fruit ripening, development of cold hardiness and fuel for shoot growth. The ambient air and soil temperature wakes the vines up in the spring and drives the biochemical reactions that push fruit towards maturity. There are physiological reasons why cool years are often late and difficult, and why wine growers pray for warmer vintages, which offer greater uniformity, synchronicity and ripeness to the fruit. Between veraison and harvest, temperature is critical to the development of the flavor, aroma, and phenolic compounds that are characteristic of the grape variety and appreciated by wine consumers and critics. Viticultural factors such as row direction, trellis design, and canopy management all have an impact on the microclimate characteristics that affect fruit maturation.

Like light, nutrients (especially nitrogen) have the effect of encouraging vegetative growth in vines, which may be large or small, but in each case too much of a good thing will make a 'fat vine', i.e. with lots of wood and little fruit. Excessive quantities of water and nutrients do not lead to fine wines. This is a hard idea for many growers to adhere to since we live in a "bigger is better" and generally excessive culture. In most aspects of viticulture, and unlike its agricultural cousin in agronomy, restraint and moderation are usually the best

Managing vine size, keeping the vine in balance, and maintaining a healthy vine will promote ripeness of the fruit and wood, our two most important goals. If the vineyard can be designed and managed to achieve full fruit maturity, then proper maturation of the wood usually follows and you will be able to count on long-term sustainability and profitability, and the success of the vineyard.

approach. Rarely will excessive amounts of anything improve the wine. You want a slim, trim vine that will ripen the requisite amount of fruit with an adequate amount of nutrients. Nitrogen is often the key to keeping the canopy under control. Maintaining equilibrium is necessary, with enough available nitrogen in the juice for clean fermentation and to avoid atypical aging problems (especially in white wines), but not too much nitrogen, which may cause excessive vegetative vigor. Nitrogen should be monitored in the grape must as well, to be sure that there is an adequate supply in the soil and vine.

With agronomic crops the goal is to maximize yields, often forcing production by the use of copious amounts of water, fertilizer and pesticides. Fine wine growers must instead seek to balance yields with quality. Especially when interpreting soil and plant tissue analysis results you should be aware that general agronomic principles are usually based on field and row crops (such as corn, soybean, wheat, etc.) and are not necessarily transferable to vines. This is not to say that they are irrelevant, but soil and nutrition principles should be applied with care in the vineyard, especially when interpreting soil tests. Viticulture is a sub-discipline of horticulture, which encompasses tree and small fruits, and vegetables. Horticultural information is usually much more transferable to viticulture. In a world overflowing with information, grape growers need to be certain that what they seek, ingest and especially, what they use, is applicable to the exact needs of the vineyard.

In the vine balance equation, there is an optimal threshold for yield and quality. Winemakers usually want the highest-quality grapes possible, but it does not make economic sense to produce one less berry than the maximum possible at the predetermined quality standard. Many wine makers and writers are compelled to push yields lower in a quest for ever greater fruit concentration. This quality-quantity relationship is a regressive one and, at a lower threshold, may have a detrimental effect on fruit quality. But why harvest 2.5 tons per acre if 3 tons will reach the accepted quality threshold? The one-half ton difference translates into about 400 bottles and that's a lot of wine not to produce or grapes not to get paid for. Each grower must determine how he can optimize yield and quality for each variety in each block of vines. Only through direct experimentation in the field can ideal yields for the desired type of wine be accurately determined.

Soil nutrient levels must therefore be tailored to wine type and style objectives. If the aim is the production of fighting varieties, then a more nutrient-rich soil is probably desirable. If a very fine red wine is the target, then limiting nutrients and their availability is necessary. This usually means finding a soil that has low to moderate nutrient levels. It is always easier to add nutrients than to remove them so starting with lower than optimal levels is acceptable. Characteristics such as pH and cation exchange capacity can have important effects on nutrient uptake. If your goal is to grow a small vine with low yields, then you should look for soil with a low to moderate pH, cation exchange capacity (CEC), and organic matter. If a larger vine what you want, then soil with these qualities at the higher end of the optimal range should be aimed for.

While viticulture offers powerful tools to improve quality, the objective should be to find a site that will not require a Sisyphean effort to achieve your wine style goals. With the right soil and plants, and sufficient light and heat to drive all the biochemical functions necessary to grow shoots, leaves and roots and to fully ripen fruit, you will already have many of the requisites for consistent vine behavior and therefore the making of a fine wine.

Pulling it all together

The art of compromise is part of developing a vineyard. In grape growing you never get something for nothing and there are lateral and downstream effects to every decision that you make. For example, if lowering the fruit wire to gain heat for ripening will reduce the airflow, which could lead to disease problems. Running rows up and down a slope will facilitate equipment operation and improve safety, but could take the rows out of their ideal orientation, as well as increasing erosion problems. Planting vines at the top of a slope or hill offers greater protection from frost and freezing, but the site will be cooler during the growing season and this could slow ripening.

There are many ways to do the same thing which exacerbates the decision making process. Ten growers will have ten different suggestions on what kind of post to use and how to install it. It can get frustrating to sort through the options, but a best answer must be found based on sound information. There is usually a better and a worse decision, and sometimes even a clear-cut right or wrong way to do something. Looking at the successful application of a solution is always a good guide.

These complex interrelationships are what viticulture is all about and it is up to the grower to achieve balance and harmony in his vineyard. How will you know when you have achieved viticultural utopia? Only the mature vine with fruit and, later, the wine will provide the answer. *In vino veritas* is really true for the wine grower. However, you can use the guidelines of viticulturists such as Dr. Richard Smart to make sure that you are moving in the right direction. The golden rules are expounded by him in *Sunlight into Wine*, a 'must read' for every new grower. Other expert viticulturists have their own criteria for ideal vine size, balance and harmony, which should be taken into consideration as well.



Chapter 10

Site Selection: The Single Most Important Decision a Grape Grower Will Make

The special and specific characteristics of the site, primarily soil and climate, will determine the quality of the wine harvested from it. There is no getting round this simple truth. If great wine is the goal, a great site is necessary to grow it.



Could this be a great vineyard site?

The challenge of choosing a site in the East

This manual is unabashedly biased toward the production of high quality hybrid and *vinifera* wines, the best of which should eventually compete at international standards of quality. While *vinifera* wines may not be the most popular or even the best wines in the East at present, they constitute the critics' opinion of a wine region's status measured against international benchmarks. These varieties happen to be the most challenging grapes to grow in the East. In the Mid-Atlantic region around or below the Mason-Dixon Line, the mark of a great vineyard site is its ability to get Cabernet Sauvignon to full

maturity on a consistent basis. To date Eastern wine growers have struggled with late red varieties, including Cabernet Sauvignon, Cabernet Franc and Chambourcin. Correct site selection is the answer to this and to the many viticultural problems in our region.

New wine regions tend to adapt (or force) viticulture onto a substandard site. I advocate a new paradigm which is to start by finding and planting the best vineyard sites. It always takes time but with available GIS data and analysis and mapping technologies, accurate high quality site assessment is possible. Of course, there is no substitute for "ground truthing" results and only by planting and making wine can the potential of a site be truly understood.

The selection of the vineyard site is the most important decision you will make. It should be guided by goals set for the wine (type, style, price point, etc.), which will then influence all subsequent viticultural decisions. For example, to grow grapes for 'box, jug or fighting varietal wines' a field with deeper, more fertile soils located outside of a frost zone would be desirable. If the goal is a 'Parker 95', the vineyard site requirements will be entirely different. Eastern wines quality is currently driven by a lack of high quality sites, and relies on viticulture as a crutch to compensate for site deficiencies. The contribution of the site to wine quality will improve as the optimal combinations of soils and climate are found. In the best vineyards in Europe the site leaves its distinctive mark or "typicity" on a wine. It is thought-provoking to observe just before harvest the rather messy canopies in a great vineyard in Medoc compared to the fastidious care of a Jeff Newton vineyard in California where every shoot is individually positioned, yet the quality of wine from Bordeaux is consistently excellent. This is surely an expression of vine balance in a great vineyard site. It is our mission to find the places that can achieve this rare quality of balance in terroir.

Types and styles of wines usually follow the terroir from which they are extracted. Arid regions like California, South America and Australia tend to offer bolder wines that reflect the sun-drenched conditions which they are grown. It is not easy to force a variety to grow out of its comfort range and that is why there is not Cabernet Sauvignon grown in the Mosel or Riesling is no longer considered suitable in Yountville. Some varieties are more flexible than others, but most wine regions aspire to the wines that best express their unique terroir.

Cooler areas with variable climates produce quite a different kind of wine, which could be described as a 'European' style: fresher, lighter, more elegant. Wine writers say that cooler regions such as Germany, Alsace and Burgundy are among the most expressive of their terroir. Much of the Eastern U.S. is such a region, sometimes in the extreme; there are few areas in the world with such variable and adverse conditions in terms of fine wine production. Too little sun and too much rain can push wine quality over the cliff in poor vintages such as 2009. This is why site selection is paramount in the East, because it offers the best hedge against harsh vintage conditions. The smart wine grower prepares for difficult conditions by finding a site with meritorious features and then backing them up with excellent viticulture during the growing season.

In a survey of growers conducted for this manual, site selection was identified almost unanimously as the most important factor determining grape quality. There are few accomplished wine growers anywhere in the world who would dispute this assertion. In regions such as Bordeaux and Burgundy it seems that the growers know their soils better than their spouse or children. Here in the East we accept the principle, but still little is known about what constitutes a good site to grow fine wine. We can state with confidence that great Riesling and Gewurztraminer can be grown around the Finger Lakes, but we have not yet identified exactly where the best places are, much less the why they are special. It has been demonstrated that in the Mid-Atlantic region Bordeaux reds can make delicious blended wines, but there is little consensus on the ideal terroir. Until recently in the East few vineyard sites were chosen solely on the basis of their wine-growing potential, so we have been working with a handicap when it comes to making fine wines.

The process of site selection is a combination of science, art and intuition. When experienced eyes see a vineyard site for the first time, they can almost taste the wine that will come from it. That's an intuition that shouldn't be ignored but it must be based on local and international experience. What must validate intuition is a careful analysis, because vineyards are complicated systems and much of the terroir is not in view. Each vineyard is genuinely unique and requires careful analysis to understand. In fact, only after farming a particular vineyard for many years will its true nature be revealed. In well-established winemaking areas in Europe and even California something like a recipe may exist, but ultimately it comes down to planting the vines and tasting the wines produced by a particular piece of ground.

For those who do not want to wait that long there are new technologies, such as the *New York Vineyard Site Evaluation System* (see below), that allow you to analyze vineyard sites with remarkable precision using existing soil and climate information in a GIS database. Intelligently applied, such tools can help new growers to close the quality gap more rapidly than in the past, but they can only push quality so far. Technology will never have the final say, because assessing the potential of a site requires walking over it, digging a hole to see what is underfoot, and learning how the climate above will affect the vines. The true quality of a site will only be revealed over time by the vines.

A general rule that holds in cooler wine districts such as the East (perhaps definable as above the Mason-Dixon line) is that warm and dry vintages make fine wine, while cool and wet years are more challenging. Site selection is especially important for red wine grapes, which tend to be more demanding due to their generally later ripening periods (exceptions being Pinot noir and the red hybrids). Therefore we want to maximize certain qualities in order to make the most of less than ideal vintages. In a damp climate the need for specific characteristics such as a warm site, well-drained soil and a drying breeze are absolutely vital, and these virtues cannot be over appreciated. Site selection in the East is an ongoing learning process but is currently limited to generic site selection rules that apply to vineyards everywhere.

In the East water is a precious and available commodity that wine growers spend a great deal of time worrying about. Ill-timed rainfall can severely compromise wine quality. A soil that drains poorly will retain moisture, which can lead to “wet feet” (where vines are stressed due to the lack of air in water-saturated soil) or to an overly vigorous vine that may suffer from disease problems and does not allow the fruit to properly ripen. For these and many more reasons significant measures, both natural and artificial, will be needed to combat the harmful effects of excess water. The unfortunate irony is that water can also be scarce, which means that sometimes supplemental water is needed from an irrigation system, a costly expense. This is a typical viticultural conundrum: you can’t live with too much or too little water and – this being agriculture – all vineyards will experience both conditions.

Site selection is a process where patience meets determination. It is daunting that the most important decision a grape grower faces is among the very first that must be made. It will take plenty of skill and luck to find the right place to grow the grapes for the intended wine. Fortunately, there is a lot of information and experience to draw upon. You are not alone. Looking at other successful examples will help to inform and support the planning process. This needs to be an information-rich process using data mined from all manner of sources. So learn the basic principles, get sound advice, and remember that paying attention to the smallest details now will reap significant benefits later.



RdV in Virginia: SE-SW aspect, steep slopes, and rock all join together to make a great vineyard site

Vineyard Development Process for Coastal Vineyard Care Associates

*Jeff Newton, Founder and Co-owner
Coastal Vineyard Care Associates
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The most important decisions in the history of a particular vineyard are those made before a vine is ever planted – during the vineyard’s planning process. Decisions relating to block design (size and row direction), clone and rootstock choices, vine spacing and trellis type are all critical to the success of any vineyard.

The approach of Coastal Vineyard Care Associates (CVCA) to vineyard planning relies on three aspects of the development process: 1) site assessment, 2) recommendations, and 3) construction.

Site Assessment

Site assessment is comprised of five key components. First, a **visual survey** of the property will reveal slopes, vegetation patterns and general uniformity. Second, a **soils analysis** prepared by a trained viticulturalist with a PhD in soil science will eliminate sites with inherent problems such as excess salt, boron or magnesium. Likewise, a soil evaluation can confirm the positive aspects of a site, including beneficial soil texture and structure, percentage of stones, and chemical composition. Third, a **climate analysis** will indicate the varieties that will be most successful at that site. Climate analysis can be done informally, using data gathered from neighboring vineyards or by using weather stations, especially in new vineyard areas. Weather stations will track temperature, rainfall, relative humidity, wind speed, etc. Fourth, **map development** by a qualified mapping consultant can, with the help of geographic information systems (GIS) and a global positioning system (GPS), shed light on the soil and topography, providing a framework for organizing vineyard blocks. Fifth and last, **client evaluation** will determine the client’s interests and financial resources. For example, it is important to know if a client wishes to set up a combined vineyard and winery project capable of producing wines at the highest level of wine quality. These so-called “luxury wines” sell for top prices, but also demand a significant financial commitment. Or does the client prefer to sell grapes to wineries producing “premium wines” that cost less than luxury wines, thereby requiring lower vineyard costs. Decisions regarding vine spacing and trellis type will differ significantly based on the type of project desired.

Recommendations

Once the assessment phase is complete, key vineyard recommendations can be formulated. **Variety choices** are normally determined by climatic factors – e.g., cool areas favor Pinot noir and chardonnay and warmer areas favor Sauvignon blanc and Cabernet sauvignon. Multiple **clones** are recommended to provide diversity. **Rootstocks** are chosen for their resistance to phylloxera, nematodes and limestone and for their impact on vine vigor. **Block shapes** are determined by uniformity of slope and soil type. Block size will be smaller for “luxury wine” projects and larger for “premium wine” projects. **Row direction**, when no slope constraints exist, is generally N-S in cool areas, NE-SW in warmer areas. **Planting density** is critical for wine quality and must be high for “luxury wine” projects, i.e. 2500 vines/acre. For “premium wine” projects, lower planting density is dictated for economic reasons, i.e. 1000 vines/acre. **Trellis design** for our mostly low to moderate vigor vineyard sites is restricted to the vertical shoot position (VSP) trellis or some variation, like the narrow “V” trellis that is used to “fluff up” the canopy to prevent excessive sun exposure.

Construction

Construction, which includes six stages, begins with the development of **infrastructure**, including water wells, reservoirs, drainage systems and roads. The future vineyard blocks are **amended** with gypsum, limestone and compost, as recommended in the soil reports. The blocks are then **ripped**, usually to a depth of 3 feet, but in some instances to 2 feet. Standard rippers pulled by large cats can rip one time in the vine direction only, or two times in different directions (cross-ripping). Ripping can also be done with the very effective “wing ripper”. **Irrigation design and installation** are carried out by contractors with expertise in vineyard installation. Finally, **trellis installation**, which includes line posts, training stakes, end posts and wire, is done by experience crews. **Planting** is the final stage and includes pre-irrigation of the planting area, holes that are hand-dug to an appropriate depth, and careful vine placement with backfilling of the hole to exclude air near the roots.

Some considerations before you start

Many people already have a property in mind when they decide to plant a vineyard, such as a farmstead that has been in the family for generations or a working farm whose crop portfolio would benefit from greater diversity. In my work I see far more sub-standard properties for wine than fine ones – the discouraging fact is that high-quality vineyard sites are very rare and your property is likely to be a poor to mediocre place to grow high-quality wines. The question then switches from ‘What is the best place to start to make a fine wine?’ to ‘How can I make design and viticulture accommodate a weak site?’ The same viticulture principles apply to all sites, it’s just that a good one demands far fewer inputs. You may have to resort to some compromises and “band-aid” measures to make up for site deficiencies, but with current technologies most sites can be adapted to grape culture – a poor soil can be ameliorated, a north slope can be planted with white varieties, savvy variety and rootstock choices, and so on.

When a wine region is mature, a definition for a fine vineyard site emerges. Outstanding vineyard sites do not just happen; they are identified after intensive research, and even then only time will tell if a certain combination of soil and climate characteristics is suited for fine wine production. The search can take one day or several years depending on the wine objectives. In Pennsylvania, the best vineyard sites are probably located among the fruit trees in Adams County or the rolling, well-drained soils of York County. In most site selection situations, compromises are made and then the evaluation process will begin. In densely planted areas such as the North Fork of Long Island, a sketch of what a quality vineyard looks like has emerged over time.

To aid in the search it is important that a specific list of site criteria be drawn up and applied to the selection process. This can be done with the help of a consultant and should be shared with an assisting farm realtor. Characteristics such as soil, local and regional climate, slope, aspect, elevation, local topography, water sources, and potential problems (proximity to woods or neighbors, land use, utilities, zoning, buildings, etc.) will all come into play. One strategy is to identify a successful vineyard and buy one nearby, but it is rare to find contiguous vineyards except in such areas as Long Island and the Niagara Peninsula.

The care taken in evaluating properties will help to lower the risk of acquiring a marginal site. For example, slight changes in soil and topography can have a great impact on the vines. One grower explained to me how in a rainy season it is always the vines in the lower sections of the vineyard, or even in slight depressions in a vine row where soils may retain moisture or are more fertile, that have more vigor or shut down later, resulting in greater disease or more winter injury problems. In France cereal crops are planted in the low spots where the soil is too fertile and frost conditions prevail, while grapes are often found on gentle to steep slopes. There is a viticultural dynamic in every site that combines soil and climate conditions to good or poor effect. Good growers (or novices with their consultants) are able to observe and understand these relationships and take advantage of or avoid them.

The most experienced growers in a region have a sense of where the best sites are located based on their collective wisdom, and as you search for a site you would be well advised to consult with them as well as local viticulture extension educators. A real estate agent who specializes in agriculture can also be a helpful guide, although you should keep in mind that they are more accustomed to finding properties for agronomic or livestock use, so you must make clear distinctions that they can apply to the selection process. If you identify a general region for your vineyard, they can find properties based on simpler criteria such as size and general topography.

At this point, you should already have a rough idea of what you can afford to spend on land. The purchase of a site will be a significant portion of the project budget (unless you already own a property) and the debt service will determine the period of negative cash flow. Most people have little concept of exactly what is an acre of land: how big it is, how many vines it can contain, and how much work it will take to manage them. It is prudent not to become overextended, and to emphasize quality over quantity. It is almost always preferable to start small and grow into a project unless professional developers and managers are in place from the beginning. A conservative economic plan should guide the purchase and development of the property. Vineyard owners often have other sources of income that can help to prop up business plans, but even the most robust income can succumb to the weight of capital development costs. Once money becomes an issue, the project loses much of its luster.

The initial evaluation of the site

The initial site survey can provide extremely valuable information. First impressions are important and will set the tone for the decisions to follow. Walk the property with a grower and/or consultant who has local experience to determine if any “deal breakers” exist (e.g., wet soils, frost hazards, poor aspect, too steep, EPA superfund site, etc). The potential of a site can be quickly recognized from its physical features. Studying the local vegetation will shed light on qualities of the soil such as drainage and fertility. Features like slope, aspect, and local and absolute elevations should also be critiqued. Walking a field after a heavy rain can reveal drainage characteristics. Try to visualize the field planted with vines according to row direction, block shape, size and position. What are the variables surrounding the field that will affect the vines (such as trees, hills, etc.). It is difficult to determine the exact “lay of the land” when tall grass, corn or other plants are growing, so in order to accurately assess the shape and contour of a property it should be mowed before viewing.

The site history can form an important part of the property evaluation. This includes information on prior crops, livestock use, pesticides and fertilizers applied, water tables, hard pans, mining, dumping and so on that will shed light on the present quality of the soil and its past management. For example, if herbicides have been used recently, such as Atrazine on corn or Poast on soybean, some remediation work may be needed. Knowing crop yields may offer insights into the productivity of the soils on the property. However, do not let prior crop use mislead you. In Lancaster County, Pennsylvania, where the soils are considered to be very fertile, corn and soybean reign supreme, but eroded hilltops with Bedington series soils have a high rock content and are well suited to wine grape production.

Vineyards promote a monoculture and it is tempting to focus solely on the needs of the vines, but the property is part of a larger ecosystem and site evaluation should be sensitive to this. Farmers need to be ecologists and to assume the responsibilities with regard to the environment and its inhabitants that come with land stewardship. The concept of sustainability should inform every development and management decision, including the selection of your site. Look at the vineyard not simply as rows of cultivated vines, but as a whole farm system that includes a variety of habitats from watershed to riparian. Can you develop a vineyard with the smallest possible impact on the natural ecology? If these concerns are addressed, it will be possible to dramatically reduce the imposition of the vineyard on its ecosystem. Be aware of what your neighbors are doing, for example, corn, soybean and pristine lawns next door may lead to problems with herbicide drift into the vineyard.

Soil evaluation

Analyzing the soil is like looking into a crystal ball. It offers a chance to predict the eventual size and balance of the vine. Soil evaluation is necessary once the property passes the walkover inspection by a knowledgeable viticulturist. The best and most practical time in vineyard development to ameliorate the soil is before the vines and trellis are installed. Therefore, the soil chemistry, biology and physical features need to be carefully assessed at the beginning of the development process. The physical features are very difficult to alter and attempting to do so often causes more damage than good. The soil chemistry on the other hand is more readily modified.

The problem with soil is that we only see the top of it, when it is what lies below that matters most for the wine. There are few sites where the soil will be uniform in texture, drainage, nutrient status and composition over a wide area. This lack of uniformity makes it a challenge to understand what site-specific practices and actions are needed within the vineyard. Some useful facts about the nature of a soil can be extrapolated from surface features (topography, vegetation, rocks, drainage), but this is usually not enough information to tell us whether a soil will be good for fine wine. In wet climates the soil matters even more for successful wine growing.

Is there a best soil for wine? This would be hard to define, because soil interacts with so many other terroir components. There are types of soils that seem to produce fine wines around the world, such as limestone-based and gravelly soils. Heavy clay soils, with a few exceptions like the blue clay in Pomerol, are not usually identified with fine wine production. If great vineyards soils exist in the East, they still need to be identified, tested and mapped. Based on early results the granite in northern Virginia, shale in southeast Pennsylvania, and gravel by Lake Erie and the Finger Lakes appear to make excellent wines. This is a starting point, but only time and serious technical work in the vineyard and cellar will lead to a level of knowledge of Eastern soils comparable to that of the French.

In the East, the quality of almost every vintage hangs on soil moisture – whether there is too much or too little of it (just right is a rare occurrence). In the best vintages soil moisture will be in a good balance with the vine and the winemaker's needs. It is quite hard to generalize about something as complex as the soil–water–vine relationship, but in general soils good for viticulture are well-drained, warmer and lighter with larger aggregates. They may be gravelly or with coarse rocks that lower the nutrient values and retain and release heat. These warm soils promote fruit maturity and an early harvest, valuable assets in a cool region. Cool soils are often deep, fertile and moist, higher in clay and silt content, and do not warm as readily. In a drought year cooler soils can help to maintain the vine. Warmer soils activate the vine earlier in the spring, thus starting and, wishfully, ending the season earlier (an advantage except in spring frost-prone areas). In wet years the drainage capacity of a soil comes to the fore; this is primarily a function of the soil's structure and texture and the slope of the vineyard. It is important to remember that as far as soil moisture and nutrients are concerned, it is always easier to add than to remove them from the soil when you want to have an impact on the plant. Even though soil is crucial to wine quality, most of its effects are indirect, influencing viticulture characteristics such as vine size and vigor.

Understanding a soil begins with a walk over the field and looking at the surface characteristics, rocks, vegetation and indications of drainage or the lack of it. Grapevines prefer to have “dry feet.” Wet soils are cool and lack the oxygen that is essential to proper root

functioning. It is much easier to discern the physical features of a field if the vegetation is cut low. A cornfield is very hard to interpret, although yield variations across a field may offer insights into the soil.

The walkover should be followed by an examination of backhoe pits or soil cores by an experienced soil viticulturist who can interpret the physical, chemical and biological properties of the soil relative to your wine goals. A complete soil analysis will include an organoleptic evaluation – sight, touch, smell and in some cases even taste to determine its viticultural potential. Chemistry may be the most familiar component since you probably have done a soil test on your lawn, which generated a report with numbers and recommendations. The physical interpretation of a vineyard soil is just as important, especially with regard to internal drainage, but here the examination is more visual and textural. In our discussion of vine balance we compared the soil to an engine that fuels vine processes.

Making use of soil tests

Soil tests are essential if you want to understand the fundamental nature of a soil. The fact that they are so easy to conduct may tempt you to rely on them at the expense of physical properties (structure and texture) when determining the worthiness of a site, so you should remember that: (a) the results are only as good as the sample that has been taken and its correct interpretation, and (b) they only represent a snapshot of the conditions at the moment of sampling. Soil samples can reveal nutrient deficiencies, toxicity or other anomalies that may render a property unsuitable for vines or that can be ameliorated. Soil tests highlight chemical properties such as pH and cation exchange capacity, which influence nutrient uptake, and the organic components, all of which will have an impact on vine size and health.

All of these variables must be weighed and balanced to service the type of wine intended for the site. The tests should be done prior to planting so there won't be any surprises later on, allowing for adjustments to an open field. These initial tests will also provide the all-important baseline reference data for the vineyard's soil chemistry. Test both the good and the problematic areas to establish these reference points and continue to evaluate them regularly in order to build a soil chemistry database that is representative for each location.

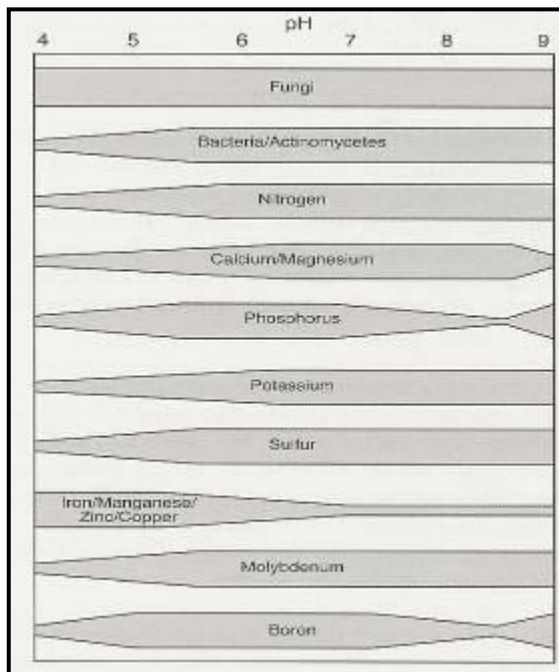
The novice grape grower may not be able to understand the results of a soil test right away. The testing lab can probably provide an interpretation, but it may not be from the viticultural perspective that is needed. Test results are only useful if you get the right person to read and evaluate them, and this should ideally be a soil scientist with a clear understanding of viticulture and your wine goals. You can do the soil tests yourself, but you will probably be better off hiring a consultant to take the samples and provide a proper interpretation as part of the evaluation process. Soil samples can be analyzed by private laboratories such as A&L Eastern or land-grant university labs such as the one at Penn State or Cornell (a list of services is provided in the resources section). A facility with viticulture experience would be the best choice.

Soil qualities

To produce high quality wine grapes, a soil of modest fertility is preferable, and low to moderate pH, organic matter, and cation exchange capacity may be beneficial. Soil pH affects the ability of roots to take up soluble nutrients. Soil pH in the East is generally acidic and sometimes drops into the fours, a range that is not ideal for *vinifera* vines. When the pH goes below 5, vines may have a problem with aluminum toxicity and phosphorus deficiency. Various forms of lime and gypsum can be used to adjust the pH upwards and the situation can also be

improved by using the rootstock Gravesac, which is tolerant of low pH soils. For viticulture purposes a soil pH between 5.5 and 6.5 is optimal, and up to 7.5 is considered acceptable. In some areas high-quality wine growers will aim for soils with a pH between 5.0 and 6.0 as a tool to regulate vine size by influencing nutrient uptake. If the pH goes above 7.5, vines may develop iron chlorosis and zinc deficiency.

High nitrogen levels can lead to excessive vine vigor and problems with vine balance. Nitrogen is a particular troublesome nutrient since it can cause problems at both luxury and deficient levels. Agronomists prefer soils rich in N because of their productivity for crops like corn and soybean. But for grapes, it is critical to keep nitrogen at optimal levels in service of the wine – lower N for premium wines and higher amounts with increasing productivity. Be aware of soil test results, especially from labs that focus on agronomic crops that recommend large



Nutrient availability chart according to soil pH

inputs of nitrogen. Like water, nitrogen can encourage too much vine growth, which has many negative consequences for grape and wine quality. In most matters of the vine, restraint is a better attitude than “more is better.” It is almost always easier to add something later than to try to take it away. The fine wine grower is look for modesty as opposed to luxury, except in the final quality of the grapes.

Knowing a field’s history can help to predict its viticultural future. Was it in pasture for decades? If so, years of manure accumulation will have had an impact on its soil chemistry. Like nitrogen, organic matter should be balance, usually in the moderate range, from 2% to 3%. The goal is to have sufficient mineral nutrition to maintain a healthy vine, but not so much that you end up with a big vine. Seek out specific and viticulture-based recommendations for soil amendments.

Soil testing procedures

Any soil test will come with specific instructions, but there is usually not a standard method for testing in vineyards. In general, taking mixed samples to obtain an aggregate profile of a field should be avoided. Since vine roots can go deep, it is helpful to determine how the chemistry changes with soil depth. For mapping and amelioration purposes, sampling across a field should represent points and transitions from one sample site to the next. This is the best way to map a field and plan the necessary corrections to achieve uniformity.

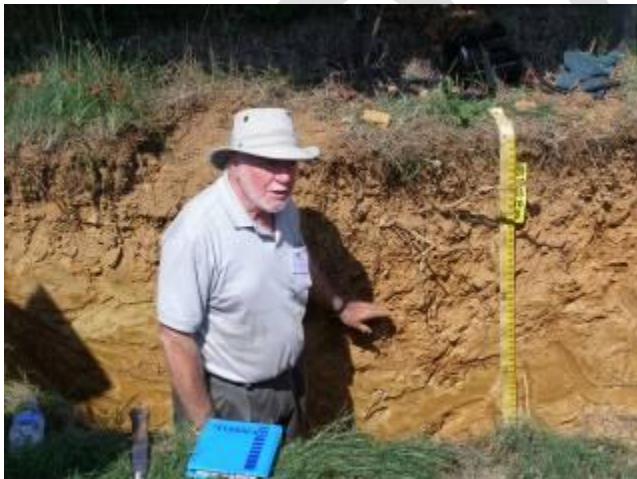
Farmers rarely worry about the soils below plow depth, but it is important for you to get a closer and deeper look in order to determine the difference between farmed and natural soils in the vineyard area. In Eastern wine growing, the physical characteristics of a soil may be more important to wine quality than the chemical profile. Eastern soils tend to be well balanced, although sometimes too fertile for the size of vine that makes the best wine. But if your goal is higher production, a more fertile soil may be desirable. The physical properties of a soil can be determined most accurately using back hoe pits. Soil cores are helpful, but less revealing of a

soil's physical properties. Both methods require an experienced soil scientist to interpret the results accurately.

Backhoe pits are the best way to examine the soil's physical features and may also offer clues to its chemical properties. Most vine roots occupy rip or plow depth (12-36") so it is important to sample at 12", 24" and 36", and possibly to take an even deeper fourth sample. A well-drained soil is often correlated with the rock content; more rock enhances drainage. Most farmers dislike rocks in a field but wine growers often celebrate the presence of up to 50% rock content in vineyard soils. The shale soils of southeast Pennsylvania, for example, are excellent in terms of drainage. Backhoe pits allow a view of the entire soil profile (horizons) from the thickness of the topsoil to, in some cases, depth to bedrock. This is important, because it is the zone that the roots will inhabit. The analysis can also reveal other features that might affect vine performance such as hard pans, fragipans, and high water tables. Hard pans indicate a need for subsurface drain tile to assist water evacuation.

Backhoe pits will reveal the texture and structure of the soil at various depths; the rooting pattern of existing vegetation; and characteristics such as particular aromas, colors, textures, etc. that offer clues to the experienced soil viticulturist or scientist regarding the overall quality of the soil. If there are sulfur odors or black streaks through a profile the soil may have drainage problems. Wine growers generally try to avoid cold, wet soils.

Everything should be noted while the pit is open. Once its properties are known, you will have a much better idea of how the soil will influence vine growth and health. It will also give you a chance to make adjustments, such as sub-soiling for compacted soil or adding lime to adjust pH or compost for nutrients. A basic understanding of soil science will help you to analyze and interpret your soils and there are a number of excellent textbooks that are accessible to the novice wine grower.



Viticulture soil scientist Alfred Cass at home in a soil pit in Virginia

should be dug where soil survey maps indicate that changes in the soil or obvious problems may exist. A good soil scientist will supplement maps with their own instinct of where soil changes may occur. The number and location of the pits will vary depending on the site, but generally one to two per acre should be sufficient. If a field is quite uniform fewer pits will be needed, whereas fields with greater variability will require more sampling. Jan Waltz, an experienced grower in Lancaster County, has underlined the importance of sampling across different contour sections and different cropping systems (such as corn, soybean and tobacco) in a field. A field

The soil pit should be dug the day before or on the morning of the assessment following the instructions of the soil scientist. In general it should be 4' to 5' deep and 24" wide with sloped entry and exit sides. The soil must be in a normal moisture condition at the time of the evaluation and there should be no threat of rain on the day of the test. Safety is a concern when someone is in a soil pit and the risk of a cave-in should be taken seriously.

Most landowners will allow you to dig pits on their property for evaluation purposes. It may, however, be difficult and/or expensive to find a backhoe. Pits

that was just used for corn may sample differently from the fallow section next to it. If obvious soil differences or problems emerge, these areas should also be tested. Generally soil pits should be dug on slopes at the bottom, mid-section and towards the top. The objective is to get a global view of the various soils in relation to the topography and other land features of your site.

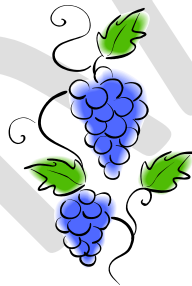


Rutger de Vink and soil scientist Alex Blackburn digging soil cores

will pay long-term dividends in terms of the quality of the site. This information is crucial to an understanding of the soil component of the terroir of the site. It represents core knowledge of the site that will serve as a reference resource for the life of the vineyard.

Data from soil pits and cores should be synthesized into a comprehensive soil map. Are detailed soil maps strictly necessary? No, but the best growers rely on them to make critical decisions about rootstocks, varieties, irrigation, nutrition, vineyard design, trellis system, and vineyard floor management. If vine and vineyard uniformity are necessary for high-quality wine production, then soil maps are the key to achieving this. They will explain differences in the soils and allow for correct viticulture assignments and management that can build uniformity into a block of vines.

They constitute an up-front investment that



Soil Evaluation and Soil Mapping for Vineyards

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Soils and the art of soil science are becoming readily accepted as a must for anyone who is entering into the process of site selection, block layout and variety/rootstock selection, and vineyard management for a successful vineyard. There is a considerable amount of very good information that has been written about soil science for vineyards in the arid West and we have been using this information as pertinent here in the East. However, although much of this information is valid, there are dramatic climatic differences that should be taken into consideration in interpretations of specific soil characteristics and how that information can be used to benefit quality vineyard production in our humid climate.

Vineyards are long-term and expensive investments. Prior to entering this type of business every aspect should be carefully considered, from site selection to site preparation, planting, rootstocks, harvesting, irrigation, fertilization, etc.

What are your goals?

Are you interested in vineyards as a hobby or are you intent on serious production? If your goal is production, do you want to produce fine quality fruit or are you more interested in mass-producing lesser quality fruit? These are important objectives to fix so that you can select the property and site which will accomplish those goals.

Choosing land to start a vineyard

Do you own your land already or are you looking to buy a property specifically for the purpose of growing a quality vineyard? We always recommend looking for the land that will suit your needs first. Otherwise, you will be restricted to the site characteristics and soils available on the property you own. If you already own land and have not yet consulted with anyone about soils or site characteristics, soil mapping will be useful to identify the best areas for vineyards and selecting appropriate rootstocks and management techniques.

What should you be looking for in a vineyard property?

Geomorphology or the evaluation of landforms is integral to mapping soils. In my opinion slope may be the most important site characteristic to consider in the humid East. Because we average 40 to 50 inches of rain per year, which happens to coincide with the harvesting and planting seasons, this is critical. Slopes of 10 to 25% are good for planting on, particularly if the aspect of the slope is convenient for planting up and down the hill. The slope insures that the majority of rainwater will run off before it enters the ground and therefore protects the fruit quality from being ruined when rains happen just prior to harvest.

Soils are far more complicated to understand than the concept of slope but can have just as much or more impact on the vines and fruit quality. As previously mentioned, soils that have good agricultural potential for cultivated crops are often too fertile and have too much plant available water for quality fruit, but may be ideal if your objective is high yield. Excessive vine vigor is often associated with more fertile soils. Soil fertility is closely related to the parent material, so understanding the geology of the site is important. Shallow to moderately deep soils and those with high rock content are often good, as they both generally correspond to lower plant available water. Controlling the plant available water is most often the challenge here in the East and therefore slope and soil makeup (depth, texture, structure and rock content) are specific soil characteristics that are important to have evaluated.

Soil evaluation continued >

Blackburn: soil evaluation...

Soil Mapping

Mapping and understanding your soils are important to the planning and establishment of a successful vineyard. The soils map spatially separates the different soils into land management units. In other words, soils that are similar can be managed with the same techniques and should, by the same token, ripen similarly. We often see vineyards with blocks that are difficult to manage because the soils information was not evaluated prior to laying out and planting the block.

Choosing the best rootstocks to suit your soils is also important. One variety on a specific rootstock may do well on certain soils, whereas the same variety on a different rootstock may not, or alternatively it could be too vigorous.

What services are provided?

One of the most important pieces of information to have is a digital base map with 2' topography and all existing conditions (i.e. buildings, fences, roads, trees and tree lines, etc.). A digital map allows for better record keeping and assures that the soils information is accurate. The soils information is collected by certified professional soil scientists via a combination of soil augers and backhoe pit descriptions, and is then digitized and overlaid on the base map.

Based on the soil map and an understanding of how the soils will impact vineyard management, the soils scientist suggests a block layout. This information is often very useful to the vineyard consultant who is assisting with the selection of varieties and rootstocks.

A detailed report accompanies the map discussing the soils, their characteristics, and suggested management techniques. Management techniques such as whether to rip the site or not, the use of cover crops under the vines, row orientation and the need for irrigation are covered in this report.

Soil sampling is also completed as a part of this process and is done specifically for each of the individual proposed blocks. Based on the lab analysis of these samples, recommendations are made for supplementing lime and nutrients. Sampling the blocks separately is important as different soils may require different amounts of nutrients to get them productive without causing excess vigor.

Obviously, if you are just searching for the "right place", or are not interested in obtaining a full soils map and report but would like some general understanding of soils, geology and landforms on your existing property/vineyard, that information can be provided with a site visit and a soil auger.



Detailed soil map is the foundation of a vineyard design and development plan

Other evaluation tools

Even before soil samples are taken and pits are dug, there are some tools that will help you to discover the nature of your land. Together these may save you the trouble of even taking a sample by flagging a poor site, or they may reveal the potential of a good site.

Understanding the soils should begin with a careful perusal of USDA soil survey maps, an invaluable resource and one of our great national treasures. Mapping the soils across the country is an achievement rivaling the building of interstate highways or hydroelectric dams. The maps are amazingly accurate in their delineation of soils and explanation of their characteristics. The older maps were published in books that can be

found at local USDA Natural Resources and Conservation Service offices in each county (formerly the Soil Conservation Service). Much of the information has also been digitized and can now be found on the internet at the Web Soil Survey web site (see information resources section). These, along with increasingly available viticultural GIS soil evaluation systems, may be used as a general guide will help locate potential sites for vineyards. Some key soil features to look for are drainage, percent rock, depth to bedrock and percent slope, and effective rooting depth. In general, soils that are rated well drained to excessively well drained in soil survey maps would be ideal for high-quality wine grape production. Within crop categories, those soils indicated for orchard use will usually have positive features for grape growing.

Cornell's New York Vineyard Site Evaluation System

Like the soil survey, it is only one tool in the evaluation process, but a valuable one if used properly. Any digital site assessment system results must be supplemented by “ground truthing” work. It is not a substitute for a pits or cores, merely a general guide to suitable vineyard sites.

Soil compaction can pose a serious problem for any farming operation. Compacted soils deprive plants of air and water, hindering root development and nutrient uptake. A compacted soil should be treated before the vines are planted and then afterwards as needed. Ripping the soil is the usual prescribed treatment, but to which depth and in what direction(s) must be determined by evaluation. Compost and cover crops can also be used to reduce compaction. Penetrometer measurements can help to reveal the amount of soil compaction that occurs over a field, especially if it has been farmed for a long period of time.

Soil biology

Compared to a soil's chemistry and physical properties, its biology is less well understood. We know that the soil is an incredibly rich ecosystem with vital interactions going on between the plant, the soil and the atmosphere involving air, water and nutrient exchanges, and that microorganisms are busily engaged in processing and regulating many of these relationships. However, much remains to be learned and we are not yet able to ameliorate the biological properties of soil as confidently as we can adjust its chemical and physical properties. A grower will examine the soil primarily for harmful biological components such as pathogenic

Another helpful tool is a vineyard site selection system. This region-specific service is becoming increasingly available as various states with emerging wine regions develop their own. In the East there are the Penn State *Pennsylvania Vineyard Site Assessment System* (VineyardMap) and the Cornell *New York Vineyard Site Evaluation System*. Check with local cooperative extension to see if your state offers this kind of service. These systems take local GIS soil and climate data and process it based on the weighted values assigned to different categories (low winter temperature, annual rainfall, growing degree days, soil pH, organic matter, depth to bedrock, etc.) to generate in a numerical value that represents the general suitability of the property for wine production.

fungi and subterranean pests like nematodes and phylloxera. Work by scientists to understand the balance of fungi and bacteria in soils that will offer the best environment for a healthy plant has not yielded standard recommendations for vineyards. However, there are companies that will evaluate the biological health of soils and make recommendations to improve it. Samples should be taken from backhoe pits. At the very least a test for the type and quantity of nematodes should be performed. If a soil fumigant is used to treat a problem such as nematodes it can devastate the living organisms, good and bad, in the soil. In such cases an effort to rejuvenate the soil may be justified.

Nematodes are microscopic worm-like organisms that can act as vectors for harmful grape viruses such as Tomato Ringspot (ToRSV) and Fan Leaf viruses and they can themselves stunt the growth of new vines by feeding on their roots. Vidal Blanc, one of the most important white wine varieties in the East, is highly susceptible to ToRSV. Unfortunately, ToRSV also has a wide range of host plants, including many native broadleaf weeds common to vineyards, making it difficult to control the source reservoir of the virus. Analysis for nematodes, particularly in fields recently planted with grape or fruit crops, is an essential step in the pre-plant soil evaluation. If the numbers are above economic injury threshold levels, chemical or biological remediation of the soil may be needed. It is strongly advised that old orchards and vineyards be left fallow for 1 to 3 years before being replanted to allow nematode populations to subside. While they are not considered to be as serious a problem here as in California, their population and possible impact on vine health should be carefully monitored.

A note on minerality and “soil flavors”

The wine world would be a dull and unromantic place without its wine writers waxing poetic about every manner of wine to whet our palates. However, when they cross over from the tasting room into the vineyard, hazards and misconceptions are often the result. One of the most furiously debated topics in wine science is the origin of particular flavors identified with wines, such as the minerality often associated with Riesling from Germany or Chablis from France. Writers imply that there is a direct link between the slate soils of the steep slopes of the Mosel, through the vine and into the glass. In truth, there is at best an indirect affect of the nature of the soil and the flavors that appear in the wines. Chemical elements are biosynthesized in the berry into aromatic and flavor compounds that we associate with a particular terroir. But there is not, much to the chagrin of the romanticist, a direct connection between soil and wine flavors in the form of a compound that is extracted and processed into wine flavors. Exactly why clay, gravel and sand in the Medoc achieve such vastly different wines, or Syrah from the Rhone and Shiraz from Australia taste so utterly different, or Chardonnay can have so many guises around the world is difficult to explain and one reason why people have been fascinated with wine for thousands of years. Someday, science may explain these phenomenon, or hopefully not.

Climate and weather

There is an old saw that applies to grape growers, “Everyone complains about the weather but no one ever does anything about it.” When it comes to growing grapes the weather is paramount. The popular wine press will praise or kill a vintage even before the wines are released based on their assessment – right or wrong – of the weather conditions during harvest. When consumers recall great or awful vintages, it is usually in connection with the weather conditions that year. Yet most wine consumers care little about the ideal or harsh conditions

which affect wine production, they just want a good bottle of wine to share with family and friends.

The first thing a grower does each day in the vineyard, except during pruning season, is look out of the window at the weather. The weather sets the tone, strategy and work in the vineyard. Growers remember with fondness the great vintages because they were easy, fun, profitable and produced excellent wines. They try (but fail) to forget the bad vintages and their Herculean struggles to get a good wine into the cellar. We cannot escape the fact that there is a strong correlation between weather and wine quality. Wine growers love warm and dry harvest seasons. In Bordeaux warmer vintages that permitted a dry and early harvest have traditionally been the most highly praised. Arid regions are blessed with such conditions almost every year, but wine districts in Europe and here in the East are not nearly so fortunate.

Aside from whatever the wine pundits say, the weather matters in both obvious and subtle ways to vine culture and knowledge of the climate will help you to decide the best varieties to plant, how to cope with rainfall, unfavorable temperatures, and the risk of winter injury to vines, and how to make other important decisions based on the viticulture characteristics of the site. A distinction is necessary between climate and weather. In his wisdom Mark Twain explained the difference thusly, “Climate is what you expect. Weather is what you get” (Mark Greenspan). Climate is the long-range weather pattern of a region. Weather is what a grower ends up dealing with from one vintage to the next. Climate determines the varieties that should be planted; the weather determines if the grapes will ripen properly in a given vintage.

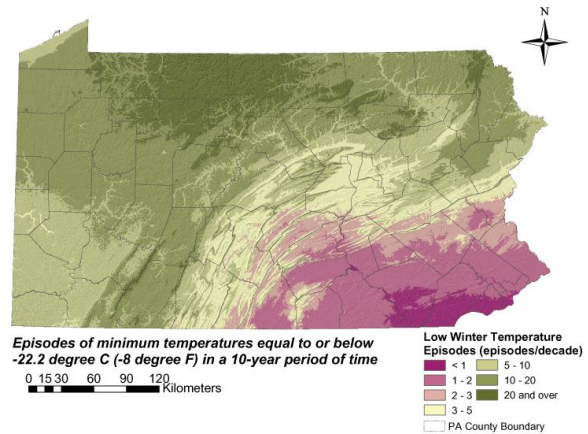
Juggling the elements

Climate is therefore important to two of the most critical viticultural goals of any vineyard in the Eastern U.S.:

- Ripening fruit to uniform and synchronous full maturity to make the best possible wine
- Ripening wood to its maximum cold hardiness condition for winter survival

If the first goal is not achieved then there is little hope of making a good wine. If the second is missed there may not be a vine remaining to reach the first goal. In fact, from Virginia to Ontario the greatest single constraint to the cultivation of hybrid and *vinifera* grapes may be low winter temperatures that can cause winter injury or death to vines. For direct evidence of the dangers that lurk at the bottom of the thermometer, ask any grower in the Finger Lakes or Ontario about the damage caused by the freezing winters of 2003/4 and 2005/6. Everything possible must be done to understand and mitigate the threat and effects of winter injury, which will upset uniformity in the vineyard and have a negative impact on wine quality. A vineyard with vines of different ages and in different states of training, with variable canopies and yields, is the opposite of uniformity. ‘Replacement viticulture’ is the disheartening term used to describe this kind of grape growing, which hinders fine wines production but is often a reality in the colder wine districts (Finger Lakes, Ontario, New England, etc.). The prudent grower needs to make avoidance of winter injury a priority in site selection, variety selection, and management. To fully understand the physiology and impact of winter injury, please read *Winter Injury and Methods of Protection* (Zabadal, et al., see information resources).

Wine growers develop an intimate relationship with the weather and get to know its every mood and emotion. The variable Eastern climate will make the grower feel as if he or she is suffering from bipolar disorder. For example, in a dramatic vintage shift the harvest in 2010 began almost three weeks earlier than in 2009. Ask the Eastern wine grower to define an average harvest or harvest date and your likely to encounter a shrug. The reality for Eastern wine growers is that they will worry about the weather almost every day in every season, even the winter. Each morning begins with the forecast and how it will impact the day's activities, vine health or fruit quality. As a vineyard site is evaluated, it is important to study the climate and weather that will affect grape culture. This begins with data collection that gradually develop into experience and knowledge of weather patterns that will provide you with a sixth sense about what the weather will be in the future and how it will affect your vines, grapes and daily vineyard operations. This intuition will prove most valuable at harvest time, late in the season and often deep into autumn, when the weather is both more unpredictable and more important to wine quality than at any other time in the growing season. Whether the climate is coastal and cool, inland and hot, continental and warm, or wet and humid, long-term climate data lets growers know what to expect. The uncertainty of the weather has been recently exacerbated by the unpredictable effects of climate change. The East appears to be experiencing extreme weather events such as hurricanes more frequently and temperatures are definitely warming. Try to find a site with a favorable macro- and meso-climate that will allow good viticulture results in bad weather.



Low winter temperature thresholds per decade in Pennsylvania (An-min Wu, 2006)

Wine growers must concern themselves with the climate on three levels:

- Macroclimate is climate on a large scale, the kind that we are referring to when we discuss climate change, or what is shown on the big map on the evening weather report. It's the big picture, covering a large geographic area, and is measured over extended periods of time, usually 30 years.
- Mesoclimate is the climate in and around the vineyard, which is affected by local effects such as topography. It is critical to ripening, frost and freeze damage, and even the amounts of rainfall that you will experience in the vineyard.
- Microclimate is the environment in and around the individual vine. A large canopy will have a different climate from a small canopy. The shade cast by large canopies is generally detrimental to good wine, because it increases humidity and reduces sunlight and air inside the canopy, causing fruit chemistry problems. Microclimate has a critical effect on the temperature around the fruit zone and how it affects the biological processes responsible for fruit ripening. The biosynthesis of flavor and phenolic compounds is largely driven by temperature, and therefore conditions in the fruit zone after veraison are vitally important to making fine wine.

Wine consumers have been told that the best wines come from places with warm days and cool nights, and to some extent this may be true. Warm days help to ripen the fruit and cool nights help the berries to retain acidity. But in cooler climates where lower acidities are desired for balance, warmer nights may be preferred. The subtle effects of temperature on vine physiology can have a considerable impact on wine quality as they play a role in many of the biological processes and the formation chemical constituents of wine. Many aspects of how vines function are not well understood or documented. For example, humidity is a major factor in Eastern viticulture yet little is known about how it affects grape quality. We are familiar with the problems that humidity can cause in terms of fungal disease, but not how it influences the ripening process.

Sunlight drives photosynthesis, and photosynthesis is responsible for the production of sugar, which creates the alcohol that is so important to balance and texture in wine. In overcast areas diffuse light, while quite efficient, does not have the same strength to push sugar development. Sunlight along with other meteorological conditions provide warmth (or the lack of it) to the soil and vines. So while light and temperature are closely related they impact different physiological functions in the vine. A certain amount of warmth is critical to many important vine development (phenology) events. It is heat that warms the soil in spring, awakening the vines from winter dormancy. A fast and successful bloom period depends on warm conditions in spring. During the critical post-veraison ripening period, warmth drives the fruit towards optimal maturity. Temperature influences the biochemical pathways responsible for producing the secondary metabolites that are so critical to the flavor, color, and phenolic compounds (tannins) needed to make good wine. Acidity in the grape juice is also affected by temperature and in warm years the balance and freshness of a wine may be hampered by the respiration of too much acid. Indeed, temperature conditions after veraison and right up to harvest day are absolutely crucial to wine quality and viticulture researchers urge growers in cool regions to keep the fruit warm. Site selection involves the careful match of the right varieties with the most suitable climate conditions to achieve the goals of wine type and style.

There is a saying among wine growers that a warm site performs best in a cool region and conversely a cooler site will make the best wine in a warm region. While grape are cultivated across a wide range of temperatures, they are most sensitive to cooler areas and lack character in hot areas. In California, which is a warm area except right on the coast, wine growers look for the coolest mesoclimate that has adequate heat accumulation to consistently and fully mature a designated grape variety, and then narrow their search to a warm place in this cooler area. If the site is too cool for the selected varieties, however, the fruit will not ripen properly and the highest quality will not be achieved. Therefore, temperature extremes should be avoided. Observing the better wine regions around the world, it is easy to see that many of them are located away from areas that experience temperature extremes, where acid, flavor and aroma compounds can "burn off" from too much heat. Many fine wine regions have a coastal influence or, if located inland, enjoy the cooling effects of a higher elevation or latitude. Cool temperatures allow for a slower, more regular accumulation of sugar and other compounds, especially in the period up to harvest. There is no strict definition of a 'cool' place, although regions like the Willamette Valley, Sonoma Coast, Finger Lakes and Ontario qualify as cool. Very hot regions such as the central valley of California are better suited for table and raisin grapes or varieties for bulk and dessert wines.

As a general rule, in wine production the red varieties are more finicky when it comes to climate than whites. Reds usually ripen later and are subject to the vagaries of autumn weather.

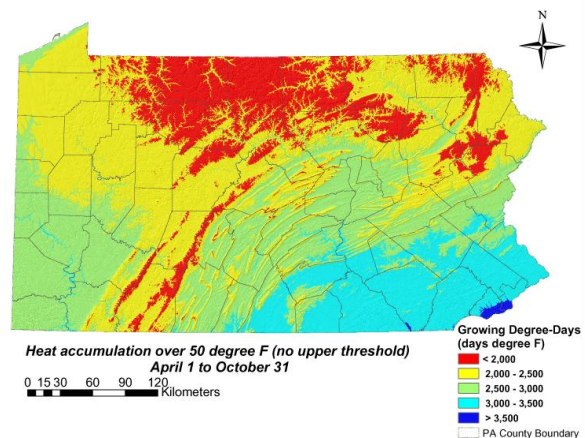
White grapes like Chardonnay and Riesling perform well over a somewhat wider range of climatic (and other viticultural) conditions. Chardonnay can be found in both warm and cool climates, where it will have different expressions. A Riesling harvest at 19 brix will taste dramatically different, although not necessarily better, than one picked at 23 brix. Syrah also adapts to a broad range of conditions, from Hermitage in the northern Rhone Valley to Shiraz in South Australia. Cabernet Sauvignon, a highly adaptable variety that is grown all over the world, needs plenty of heat to get it ripe enough to make good wine. Pinot Noir also needs to be dead ripe to make a great wine and is less amenable to different conditions than Cabernet Sauvignon.

Temperature and the vines

During the growing season, growers watch heat accumulation very carefully. They need the right amount and distribution of heat to converge into a fine vintage. Too little heat accumulation will hamper fruit ripening. Too much heat compresses the growing season and does not allow for proper flavor development. In wine growing, the most critical temperature period occurs after veraison during the final push for full grape maturity. It's also important to a successful bloom (pollination) and bud initiation for the following season around the period of fruit set. That's why during certain times of year growers tend to be more nervous than at others. Of course, frost and winter injury can cause serious temperature related problems for grapevines. 2003 and 2009 were very cool and wet years in the Mid-Atlantic region and the quality of wines reflect these conditions. In warm seasons like 2007 and 2010, wine makers rejoice. It's never easy however. In warm years aromatic whites varieties may lose acidity and aromatic intensity even as red varieties excel. It is always a matter of seeking balance between the variety and the seasonal conditions that tests the grower and wine maker.

Growing degree days

GDD or heat summation is a system that is used to measure heat accumulation over a period of time. For grapes in the East this period generally extends from April 1 to October 31 and uses 50° Fahrenheit as the baseline (marking the temperature threshold between activity and dormancy for a vine), GDD provides a guideline for matching varieties to the mesoclimate of an area. A GDD system developed by Amerine and Winkler in 1944 in California divides the state into five regions based on heat accumulation, Region 1 having less than 2500 GDD being the coolest and Region 5 with over 4000 GDD as the warmest. Specific grape varieties fit loosely into these categories. For example, cool climate varieties such as Riesling and Pinot Noir will perform well in the range of 2000 to 2500 GDD, while warmer climate varieties such as Merlot and Cabernet Sauvignon will need 3000+ GDD. Hot climate varieties for dessert wines and table and raisin grapes can be grown in regions with more than 4000 GDD.



Growing degree days for Pennsylvania (An-min Wu, 2006)

Growing degree days is a useful guide, although it only records the difference between the maximum daily temperature and the baseline of 50°F and therefore does not take into account variations in diurnal temperatures (in particular nighttime temperatures above 50°F), humidity, wind, light intensity and other key environmental factors. Despite its flaws, it has become the standard yardstick to compare temperature profiles between wine regions around the world. The heat summation of a site will help as a general guide to variety assignment. There are climate data services that use software to process land-based climate data and that can interpolate historical and current climate conditions to almost any remote site.

Frost

Frost is a great concern in almost all Eastern wine regions and in recent years climate change appears to be making late spring frost a greater hazard. Spring frost can damage or kill tender young shoots, while an early fall frost can knock leaves off a vine before the fruit is fully mature. Although it usually does not kill vines, it certainly can hamper a vintage, upset uniformity, complicate canopy management, reduce the crop, and exacerbate winter injury problems. Frost avoidance begins with selecting the correct varieties and designing a vineyard that will mitigate the threat. It is important to know the number of frost-free days for any new vineyard site and the required length of growing season for the varieties being considered. Cabernet Sauvignon typically requires a minimum of 185 days from bud break to harvest in order to ripen its grape to full maturity and needs its full complement of leaves for each one of those days. If the growing season is cut short the fruit will not ripen and wine quality will suffer.

There are both passive and active measures to confront frost and now is the time to incorporate as many passive measures as possible into the vineyard, including proper site and variety selection. Site selection is by far the best frost-avoidance strategy. Cold air settles closest to the ground and should be moved quickly away from vines. Avoid concave land features since cold air (and water) will pool in the bowl. Air flows a lot like water so features that encourage surface drainage will help relocate cold air. Slopes and vineyard borders free of impediments (hills, trees, buildings, etc) will promote good air drainage. Vineyards planted on the top or at mid-slope on a hill will usually fair better than those below. But higher elevation will mean cooler summer temperatures, which could delay ripening. Choose varieties carefully because late reds will never mature if the leaves get frosted every fall, or if early budding Chardonnay gets burned back by frost every spring yields and quality will suffer.

Active protection measures include wind machines and other devices that can provide heat to the microclimate around the vine. In California, the most frost-prone areas rely on overhead irrigation to protect new and tender shoot tissue from frost. Microjet misters and overhead sprinklers are used to coat the vines with a layer of ice; the freezing process releases heat, which warms the air and can protect green tissue to about 22°F. Note that this system requires a vast amount of water to be available on demand. During radiation frost conditions (cold air but little or no wind, which is typical of regions such as Ontario) wind fans, which mix warmer, rising air with the colder air near the ground, are used extensively for both frost and freeze protection. There are tower and low-profile machines that can cover 7-12 acres, but they need to be placed in strategic positions in order to maximize their effect. Using helicopters to mix warmer air with cold air near the ground is another measure that can be used against frost.

Winter injury

The same general conditions that increase the risk of frost damage will also exacerbate winter injury. Cold air moves and settles in much the same way as water. Low areas are always at greatest risk of frost and winter injury. These areas are typically wetter and more fertile, resulting in a bigger vine that acclimates later and more slowly than those on lighter soils. In saturated soils the vines may also be stressed. These conditions result in vines that are more vulnerable to winter injury. Do not plant vines in wet, low-lying areas in a field.

Different grape varieties have varying tolerances to low temperatures (ranging from extremely cold-hardy native species and newer hybrids (such as those introduced by the University of Minnesota) to cold-sensitive classic European *vinifera*, with many of the interspecific hybrid varieties lying somewhere in-between. The low temperature thresholds of grape varieties should be compared to the historic climate data of the site to assess the cold injury risk. This threshold is a moving target and will depend on the quality of tissue acclimation in the vines in any given year and the weather conditions during the winter. A false spring in January or February may slightly de-acclimate the vines, making them sensitive to a sudden drop in temperature. A rapid drop in temperature before the vines are fully cold-acclimated can also cause injury. Common viticulture lore supposes that the south side of vines, or vines on a warmer south slope, may be at higher risk for winter injury due to the greater warming effect of the sun on the vine, at least compared to the shaded side of the vine or vineyard.

Winter injury should be considered a serious threat to the economic viability and long-term sustainability of a vineyard. Frost damage is transient but winter injury can kill vines and all growers need to take a very pragmatic approach to this problem.

The challenge of rainfall in the East

Rain is a real problem in the East and this must be taken into account in every site evaluation. And once the growing season begins, growers are watching rainfall accumulation very carefully. Rainfall results in soil moisture, which can impact wine quality in many ways. In the East soil moisture is usually overly abundant and creates too much vine vigor. This leads to excessive shading in the canopy, which can exacerbate fungal diseases and hinder fruit ripening. In the red varieties it may lead to excessive methoxypyrazine production, which causes unwanted bell pepper and asparagus flavors. All of these are detrimental to wine quality. Supplying the vine with just enough water – through rainfall and, when that fails, irrigation – at just the right times to keep the vine active but not overly vigorous is ideal but not easy. Soils in Bordeaux – from the gravel in the Medoc to the clay in Pomerol – strike the correct balance and yet even there the cooler clays perform better in hot years and the warmer gravel will yield elegant wines in cooler vintages. This is why so much attention must be paid to soil drainage and nutrient properties, and an irrigation system may be necessary. Grape growers are continually trying to ameliorate the conditions that Mother Nature provides in any given year.

Many wine regions in the East average about 40" of rainfall annually, which is well within the limits of most fine wine districts around the world. The Sonoma and Willamette valleys receive about this amount of rain. The problem lies in the distribution rather than the total amount of rainfall. Too much or too little water at a crucial time is deleterious to wine quality. Excess vine vigor resulting from rain before, but even more crucially after veraison can damage fruit quality by causing increased disease and berry size and impeding fruit ripening. In the East there is usually an overabundance of water, particularly around or after veraison when

stopping shoot tip growth and getting the vine to focus on fruit ripening is absolutely critical to success.

In his book *The Finest Wines of Bordeaux (2010)*, author James Lawther illustrates the importance of timing of water and vine growth from research done at the University of Bordeaux:

The report notes that for the “perfect red vintage” five successive factors are necessary in the growth cycle of the vine: an early and rapid flowering (for even maturity and yield); a little water stress at berry set (to limit berry size); the cessation of vine growth before veraison (achieved by mild water stress); an adequate leaf canopy (with enough water available so leaves are active) to ensure complete ripeness of the berries; and clement conditions during the harvest to bring maturity to the later-ripening parcels and varieties.

Kees van Leeuwen, who assisted with this research and is also the viticulture consultant to Chateau Cheval Blanc in St Emilion, states emphatically that water and nitrogen are two of the most important factors in determining fruit quality and must be available in proper amounts at the correct moment to ensure the highest quality grapes.

So it is not a surprise that the best wine growers spend a lot of time and effort figuring out how to influence water/vine relations and control vine vigor. In regions like Europe and the Eastern U.S. this is a real challenge (arid regions can rely on regulated deficit irrigation). Besides soil drainage, other viticulture tools such as cover crops can be employed to reduce vine vigor in a wet year.

Rain shadows

Why do some vineyards seem to consistently receive more or less rain than others located relatively close by? The phenomenon of “rain shadows” or areas that, due to the interaction of particular land and climate features, receive less rain than surrounding areas could benefit wine growers in wet areas. It could also help to shield them from the hail events that are so devastating to vines and crops. While the pattern of summer thunderstorms appears to be random, there are some areas that typically receive less rain than others and here topographic features may exert an influence. It is well known, for example, that mountains can create this effect. A good example is the difference in precipitation between the Willamette Valley on the west side of the Cascade Mountains in Oregon and the high desert to the east. In the East rain shadows are probably much more subtle and have not been given much attention. If rain shadows can be located and mapped, vineyard site selection would be greatly improved. These conditions could be identified by talking to experienced growers, collecting your own climate data or using a climate data service to analyze the amounts and distribution of rainfall in a region. Climate mapping deserves to be used much more widely than it is now as a standard tool in viticulture, particularly in site selection.

Too much rain may lead to excessive compaction if the soil is not in optimum condition and you are constantly traveling over the vineyard rows with heavy equipment, such as sprayers to protect against insects and disease. Heavy, compacted soils do not drain well and limit root growth and overall vine health.

Wet and cool (they usually go together) produce the most resource-intensive vintages. A grower will spend much more in a wet year on fungicides and, possibly, herbicides. Because of

increased vine vigor, more canopy management will be necessary such as leaf removal and hedging. The grape quality will probably be lower and grape prices may reflect this. The harvest will be slower and more laborious, increasing labor costs. A dry vintage is certainly preferable for wine quality and the bottom line.

Understanding the vineyard climate

Climate and weather are important to viticulture and every effort should be made to understand how they will affect the health of the vine and the quality of the fruit in your vineyard. Begin by gathering any historic climate data that can be found about the site or the immediate area. A neighboring farmer or weather enthusiast, a small private airport or even an NOAA weather station can provide a wealth of information. Orchard growers are especially sensitive to weather conditions and patterns that affect grapes and can often share valuable insights into the local climate. USDA Temperature Zone charts drawn up region by region provide a good general guide to low winter temperatures and the length of the growing season. Minnesota cold hardy hybrids can survive in Zone 3, but most *vinifera* will prefer the warmer side of Zone 6 to Zone 7. Hybrid grapes can survive in Zone 5.

While you should not base any decisions regarding varietal suitability on the (still hypothetical) effects of climate change on your site, you should be aware that the boundaries of the USDA temperature zones are shifting north. Researchers at Cornell report that winter temperatures in the northeast have averaged 4°F warmer over the past decade, presumably due to climate change. Be sure to consult maps that have been updated for climate change.

Among the first things a prudent grower should do once he or she has decided to develop a site into a vineyard is to place weather stations or data loggers around their property. In just the one to two years prior to planting, much valuable local climate data can be collected and used in the vineyard design process. If this information can be supplemented with 10, 20 or 30 years of historical climate data then very informed decisions about variety selection and placement can be made. The data will also help to illuminate danger zones for frost and winter injury. Eventually the data can be used in disease and pest modeling systems to predict outbreaks or the key phenological stages of these organisms, so that you can combat them more effectively with fewer and less noxious measures.

Data loggers can help you to develop a climatological profile for the mesoclimate in and



around the vineyard or even the microclimate of the vines. Prior to planting heat summation, spring and fall frost dates, and low winter temperatures data are of interest. Collecting this data over time will help to define the overall climate patterns around the vineyard.

Conditions such as max/min temperatures (diurnal temperature shift), relative humidity, rainfall amounts and distribution, wind direction and velocity, photosynthetically active light (PAR) conditions, and leaf wetness are all key climate indices.

Two types of data loggers: Davis on left and Spectrum Hobo on right

Data loggers run from very simple, inexpensive (smoke alarm size) devices that monitor little more than temperature (max./min.) to professional grade instruments that use radio telemetry to send the data directly to the computer in your office. There are many companies that make high-quality data logger systems. One reasonably priced and reliable weather station system is the Watchdog 2900ET from Spectrum. It records the temperature, humidity, solar radiation, rainfall, wind direction, and wind speed. Onset HOBO units are small temperature data loggers that are great for checking temperatures around the vineyard site, typically at the top, middle and bottom of a slope. This is how to begin building a climate record for a vineyard site.

Growers talk about the weather constantly during the growing season. How low did the temperature dip in February? Was the weather nice during bloom, resulting in good fruit set? What will the predicted rainfall be during the critical ripening season after veraison? Is that hurricane going to swing inland or stay off the coast? The weather always matters to fine wine productions, at some times more than others. The growing season can be broken into three periods – bud break through bloom, fruit set to veraison, and veraison through harvest. The weather during the first two-thirds of the season can certainly influence wine quality, but even if the weather is relatively poor a vintage can be saved by good weather in the last third, after veraison. Hard winter freeze episodes and significant storm events after veraison are close to deal breakers for fine wine production. Analyze the risk of these events and proceed accordingly.

Post-veraison weather, as the grapes enter the stretch run for maturity, is probably the most critical and worrisome time for growers. An extended period of weather is necessary to get late reds like Cabernet Sauvignon and Chambourcin to full maturity. If it's too warm varieties like Merlot and Pinot Noir that have short harvest windows of optimal flavors may get overripe. If it's cool and wet, even the more versatile white varieties may not develop the characteristic flavors that define the variety. Bad harvest weather creates complications with diseases such as botrytis bunch rot, sour, bitter and ripe rots. And the longer the grapes are left to hang on the vines, the more predation from birds, deer, yellow jackets and others will diminish yields and quality. Grape growers should develop multiple sources of reliable weather forecasting to help plan their spray applications and harvest activities. Fortunately, with the Internet, any person can access the same information available to the television weather people. It's much easier and more reliable now to track the weather. Of course, it's still impossible to change it!

The best growers develop an intuition about the weather and use it, together with forecasting information, to guide their viticulture practices during the growing season. They do not merely respond to weather events; they anticipate them and make critical adjustments as the season develops. For example, a cool, wet spring portends a later harvest, which means that rain may become an issue with the risk of more botrytis and other bunch rots. This may require the application of four botrytis sprays instead of two and additional canopy management. Experienced growers have a sense of how the weather is affecting grape quality during the harvest season. The rain pattern may give you the impression that the progression of grape ripening is taking one step backward for every two steps forward, but when it reaches the point of one forward and two back, then it's time to pick. The decision regarding when there is more to gain than to lose by leaving the fruit on the vine is highly intuitive and depends mostly on the weather.

After years of experience growing grapes the recollection of past seasons will be colored by memories of the weather and how it affected the resulting wines. The high point could be a

single event (a hurricane or tropical storm) or simply the impression of a gloriously dry and sunny harvest season. The weather defines much of growing wine.

Other important site considerations

Matching varieties to the subtle influence of mesoclimate and site characteristics is essential to achieving consistently high quality grape results. It is never too early to try to project how the site features and the vineyard design will come together and resolve their differences and it will take many years to determine if they match well. But ideal conditions are rarely present at the same time, so compromises will be inevitable. The goal of optimal row orientation is to achieve equal sunlight exposure on both sides of the vine row during the course of the day. Uniformity is the guiding principle here, so that all the fruit on the vine will have similar chemistry and flavor characteristics at harvest. Vineyard layout and topographic features are closely integrated and should be designed to achieve the maximum viticultural advantage.

Which grape varieties will perform the best depends on the characteristics of the site you select. In the East, Cabernet Sauvignon/warm, Riesling/cool, Merlot/moderate are just some of the possibilities. The effects of slope, elevation and aspect are subtle, but can have a great impact. For example, there is a vineyard in the Finger Lakes that is laid out in long rows on a flat plain had with an almost imperceptible dip in the middle. In the winter of 2005, vines located in that slight dip were killed. There are various possible explanations for this vine mortality: the dip may have slightly deeper soils with poor drainage; higher soil moisture in the fall could have delayed vine acclimation; or in the winter, cold air could have pooled in the depression and killed the vines. In California such a dip would not have been an issue, but in the East it doesn't take much of a change in the physical features of a site to affect vine health and survival. This demonstrates that site selection, preparation and design can be a matter of life and death for the vine and make or break for the vineyard.

Slope, aspect and elevation

Either a slope or the top of a hill are desirable locations for planting a vineyard. The benefits of convex surfaces cannot be stressed enough. A slope promotes water and air drainage, although steeper slopes are prone to soil erosion, and safe equipment operation, especially on side slope, becomes a concern. Some of the best wine growers in the region stress the need for slope, even up to 20% in a wet growing region, as necessary to mitigate excess soil moisture. But even a gentle slope of a few percent can improve drainage conditions. In small vine viticulture, sloped and well-drained sites can make a significant difference to vine size and performance. Almost all vineyard operations get more complicated as slope increases, especially if the surface is wet. With slope comes aspect and the two features must work together for the greatest benefit to the vine. In most of the East, southeast to southwest slopes are most effective and north-south (or tilted slightly to northeast) row orientation is preferable. Northwest to northeast slopes, with the exception of warm areas or short season varieties, should generally be avoided. Flat fields or gentle slopes benefit mostly from correct row orientation and elevation. Slope and aspect can combine to give a vineyard an advantage when it comes to capturing light and heat, a particular advantage to ripening fruit in the cooler, later days of the harvest season.

When considering the effects of elevation on the vineyard, one must distinguish between the local and the absolute elevation. A "sweet spot" in absolute and local elevation is a vineyard in a prime ripening zone that runs a lower risk of frost and winter injury. Local elevations include topographic variations that can have a direct affect on the vines and comprises

topographical features such as hills, valleys, and plains that define the area around the vineyard. The absolute elevation is the height above sea level of the vineyard, which will influence the temperature range across seasons. The position of the vines on a hill will affect their susceptibility to frost and winter injury. The temperature will decrease at a rate of 3.5° F with every 1000-foot increase in elevation. The absolute elevation will affect the physiology of the vine and fruit ripening in the summer, and the temperatures to which the vines will be exposed in the winter.

Talking with local growers could reveal the location of potential sweet spots. In the Willamette Valley of Oregon there is a prime zone located between 400-700 feet, while some of California's greatest wines are grown in the Santa Cruz Mountains above 2000 feet. In Colorado, vines grow at a mile-high elevation in desert conditions. Among the rolling hills the northern Piedmont Plain in southeast Pennsylvania, vineyards perform well at 300–600 feet of elevation. In warmer states such as Virginia and North Carolina, the foothills of the Blue Ridge Mountains at about 1000 feet is considered to offer a nice balance between the heat of the valley floor and the cool conditions near the mountain peaks.

The local climate will be conditioned by topographical features that influence air drainage, especially in the case of cold air that may cause spring and fall frosts or winter freezes. Other phenomena such as fog intrusion will be affected by the local topography and elevation; at night the settling of cold air may push warm air higher into the hills. It's often said that the best position on the hill is the mid-section, the top being too exposed with shallow soils and the bottom too fertile with the added risk of frost. In many great wine-growing areas the best wines come from the mid-slope, but in the East the tops of moderate slopes may offer the best combination of physiographic effects, with lighter soils, moderate temperatures, and a breeze over the top of the hill.



Selecting a Site: The Scariest and Most Important Decision

*Ed Boyce, Owner and Vintner
Black Ankle Vineyard, Mt. Airy, Maryland*

My wife Sarah and I first got the idea to become winegrowers in 1998, when we were contemplating big career changes. Our goal was to grow world-class wine in the Mid-Atlantic. Given the immature state of the local wine industry, we quickly decided that site selection would take much more work than in more mature winegrowing areas (e.g. California's North Coast, Bordeaux, or Burgundy) where the key attributes needed for a great vineyard are generally known and agreed upon.

We asked several local growers what made a good site, but since most had not actively chosen a site, planting on ground they already owned, we felt we needed more insight. We eventually traveled to many of the world's great wine regions (Rhône Valley, Chablis, Bordeaux, California, Piedmont, New Zealand, etc.) and asked question after question about growing world class wine. With 20-20 hindsight (not all of this was quite clear at the time), here are the messages we heard:

The best wine is made from vines which are protected from frost/cold, don't get "wet feet", do get full sunshine all day long, exhibit strong but controlled growth, experience mild water stress at some point during berry development, stop growing at veraison, and experience as much sunny, warm weather as possible in the last 10 weeks of the growing season.

We can't do much about the weather in September and October, but we decided that careful site selection could go a long way toward the rest of our objectives. As a result, we ranked our selection criteria in the following order: well drained soil, low vigor soil, aspect (not too much north-facing land), relative elevation (if a local but biblical flood came, would your site be the first under water or the last?), absolute elevation, and farmability (slopes not too steep for equipment, stretches to plant long rows, etc.). We settled on a goal of 30-50 plantable acres, and in our area that meant we needed a farm of 100 or more acres (the non-plantable acres being too wet, too low, or too vigorous for high quality grapes).

We began by searching the internet for farms/land for sale. We took an altimeter to measure exact altitude, NRCS soil maps to get elevations, aspects and quick soil descriptions, and we started shopping for land. We quickly realized we needed the help of a good local real estate agent, and after a few fits and starts we found one. She pointed us to several properties that were not officially on the market, but whose owners might consider selling. We also looked at old listings that hadn't sold, in case the owners were still interested in selling. Finally, we drove all the county roads we could find looking for potential sites, wrote down the addresses, and our real estate agent cold called them. In this way we ended up looking at over 50 different pieces of land before we bought what has become Black Ankle Vineyards.

How did we choose among all of the properties we toured? We hired a well-known viticulturalist to help us evaluate sites, and talked with several soil scientists as well. We dug 15-foot deep soil pits to look at the soil profile below the surface. All the same, in the end local knowledge, intuition and winegrowing folk wisdom were the deciding factors. The experts couldn't say for sure whether the soils we examined would be low vigor, but the local farmers knew how much fertilizer they needed to get a decent yield (be careful of asking owners/agents this question – they always tell you that it is the most productive land in the county!). Several wine growers advised us to avoid land with nitrogen fixing crops like alfalfa because it would be too vigorous, but we found that to be wrong (in fact, smart farmers plant nitrogen fixing crops like alfalfa on their lowest vigor fields in order to save money on fertilizer). Fields on which farmers have historically struggled to get good yields are likely to indicate low vigor potential.

An old saying in Europe is "Grapevines love a view". Hillsides usually have good air and water drainage, and millenniums of erosion often take the most fertile soil down to the valleys – so we definitely got excited at hilly sites. Many of the best vineyards in Europe have extremely rocky soil, and although we never really got a definitive answer as to why that is good for wine quality (explanations we heard ranged from drainage to heat retention to weed control to mineral aromas/flavors), we decided at that, at the very least, 30% stone means only 70% soil, which would help to hold down vigor.

Looking for a premium site is a lot of hard work and it isn't a quick process (it took us 10 months of almost full-time searching to find our property), but that hard work pays off for many, many years. The patience, research, and tenacity we put into our site selection process were the best investments we have made in our business.

Trees are generally no friends to viticulture. Setting aside their beauty and any historic value they may possess, they usually bring more problems than benefits to wine quality. Wooded areas around the perimeter provide roosts for hungry birds during harvest. Trees accommodate for wild, native vine species, which serve as host plants and vectors for diseases (such as the grapevine yellows) and insects (such as the grape berry moth). Problems with deer, turkeys, raccoons, bears and other grape-eating critters, are likely to be worse if there are woods nearby. Trees hinder the welcome breezes that are needed to dry out vines wet with morning dew or rain, resulting in a higher incidence of disease. Trees also block out sunlight, especially late in the season when the sun is every minute of sunlight counts. Trees roots will compete with vines for moisture and nutrients and many rows deep into a vineyard and can stunt the growth of vines some species such as black walnut exude a toxic chemical that hinder vine growth. Root pruning can be helpful in managing wooded borders, but this requires a deep ripper, a big tractor, and time. An ample buffer of 100' or more between the vineyard's edge and any woods is recommended. All wild vines should be cut at the ground 20' or more into the woods. If possible, save the valuable and attractive trees and remove the scrap. In all cases, airflow will be enhanced if shrubs and brush is removed from the floor of the woods.



Rocks

Rocks below the surface can be big plus for a vineyard site. Rocks on or near the surface can be a pain. In some vineyards picking up rocks is a never-ending chore, but it must be done because rocks of all sizes can cause problem for trellis installation and equipment operation and longevity. Boulders and smaller rocks create uneven surfaces that make equipment such as mowers and cultivators less efficient and sometimes hazardous. Rocks in the soil beneath the vine make weed control difficult, although they may supply additional heat to the vine's microclimate. Rocks should be removed before the field is planted. Rocks can be used in drainage features and make an attractive wall around vineyards.

Pollution

Various forms of pollution can wreak havoc on vineyards. When evaluating a site, it is helpful to know what sort of activities are going on in the neighborhood. For example, brick and concrete factories emit by-products that can affect the health and quality of a vineyard. Pesticide drift or run-off from neighboring farms and housing developments, especially the volatile herbicide 2,4-D, can cause deformed leaves on sensitive vines. Problems with pollution are not limited to human activities in the immediate area of the vineyard. Ozone can compromise the health of a sensitive variety like Chambourcin. A nearby abandoned vineyard can be a source of pollution in the form of diseases and insect pests that build up over time and migrate to a neighbor's vineyard.

Biological threats

The list of biological threats to vine cultivation is long and daunting and if the cost of developing a vineyard doesn't scare off the would-be wine grower then the challenges of managing these many possible maladies should. They range from the invisible (underground or microscopic) to the very large (deer, elk, bear). Vines are very resilient plants and can tolerate a

lot of stress and strain, but alone or in combination these threats to vine health can lower productivity or outright kill a vine. Among the biotic threats are Pierce's disease and grapevine yellows, two maladies that are transported by insects and can kill vines. Like winter injury, PD is such a pervasive threat that measures throughout the vineyard system must be taken to deal with it. Fungi and bacteria like botrytis and crown gall are ubiquitous in the air and soil so they must be carefully managed to have minimal impact on vine culture. Insects feed on leaves, shoots and fruit and can transmit pathogens like leafroll virus from host to vine or vine to vine and yellow jackets and wasps Subterranean threats like phylloxera and grape root borer are out of sight but should not be out of mind. Critters from rabbits to raccoons will threaten your crop. At some point you'll have to deal with many or all of these threats but it's best to be aware of them and avoid them if possible.

Man-made factors

There are various non-viticultural factors that can influence the value and suitability of a site for vineyards. As more vineyards are being built, they are beginning to butt up against subdivisions, resulting in problems at the agriculture/urban interface. In genteel but crowded rural areas, the NIMBY (not in my backyard) attitude tends to prevail. This is an issue that you ignore at your peril. As much as you love vineyards and think they are beautiful and serene, do not assume that everyone will be thrilled by the prospect of having a vineyard in the neighborhood. In today's "worst case scenario" culture, some people will assume that you are spraying toxic pesticides indiscriminately and that the drift will contaminate their swimming pools and their children's sandboxes. The best strategy is to assuage their fears by engaging in a concerted education campaign, although you should also prepare yourself by getting to know exactly what your rights are according to the zoning of the property. Talk to your vineyard association and to other grape growers located in similar areas about their experiences. If your vineyard lies near a residential area, be extremely conscious of spray drift plumes, bird-scaring devices, and other practices that – while perfectly legal – could raise the ire of neighbors. And realize that no matter how diplomatic you are, there will probably be at least one neighbor who opposes what you are doing and who may try to take legal measures. Shared resources such as water can be impacted by the activities of your neighbors. It would be wise to assess the presence off-farm threats and the costs that might be involved in any losses or attempts to mitigate their effects. The California Wine Growers Association publishes an excellent bulletin on vineyard/neighbor relations (see information resources list).

You should be thoroughly informed regarding all land use regulations and zoning laws pertaining to your property. These are the legal foundations on which your vineyard must be built. The zoning should have an agricultural component in it. Pennsylvania township planning boards can exert considerable influence over local businesses. Environmental impact studies, while expensive, complicated and time-consuming, may be necessary, especially if you are located near a protected area, and if you neglect this requirement you could regret it later. In Pennsylvania some vineyards and wineries have had problems with local township planning boards. As with the neighbors, a little pro-active education can go a long way in answering the concerns of poorly informed or uninformed government officials. If problems persist, programs such as ACRE in Pennsylvania (administered by the Department of Agriculture) have been set up to protect farmers against frivolous obstructionism and harassment by citizens and local officials who may be attempting to block perfectly normal agricultural practices.

Infrastructure

Another vital consideration will be your sources of water, necessary for irrigation, spraying, and even frost protection. Can a spring be tapped and stored in cisterns or a pond? Is a well available and what is the quality and quantity of water available? Infrastructure requirements such as electricity, property access, work areas, and so on are important as well.

Do not rush the site selection process. Vineyards are legacy projects and decisions made up front will have consequences that last for a lifetime or more. Ultimately your vineyard must be a source of pride and joy and these emotions will be correlated to its success and the wines it produces. It truly pays to get everything right from the start. It might take a while to find the right site and in almost all cases patience is rewarded.



Soil pit at Black Ankle Vineyard, rock mixed with clay and loam



The benefits of good site selection: balanced vines at Black Ankle Vineyard - 1.5 leaf layers.

Chapter 11

Plant Materials and Nurseries

Much of the success of any vineyard development project depends on the selection and availability of correct vine materials. These vines have to go the distance, hopefully 20 years or more of productive life and income for the grower, so there is this one initial opportunity to choose the right varieties for the site and market and obtain healthy plants. Deciding what to grow is a complicated process. Nowadays there are so many components to a grapevine: variety, clone, rootstock, certified or non-certified, bench-grafted, own-rooted, one or two year old, dormant or green, bare root or potted, grade quality, etc. Therefore a lot of time and worry will be expended prior to placing a vine order, as you decide exactly how to mix and match these vine components and what kind of plants will be needed to meet wine type and style objectives. A delicate balance of viticulture and marketing decisions must be made and the permanence of the results increases the pressure to get it right from the start. It's best to consider all of your options very carefully and then be decisive and confident in the choices made. Choosing your varieties and then ordering your plants will give the project a sense of reality that a vineyard will soon appear.

Every grower interviewed for this manual stressed the importance of starting a vineyard project with healthy vine materials. Securing high-quality plant material requires considerable planning and effort, however. The timing – from order placement to delivery – will influence all other phases of the development project, especially if grafted vines are being used. If uncommon varieties, clones and/or rootstocks are selected, this can slow the entire process depending on availability. Therefore it is important to get this phase underway as quickly, but also as accurately as possible. In a down cycle market, such as during the recession that began in 2008, planting slows dramatically. California drives the *vinifera* nursery industry and plant availability is strongly influenced by planting activity there. Eastern nurseries can supply hybrid and native varieties. In a boom period, such as was experienced during the 1990's, almost all plant materials can be hard to find.

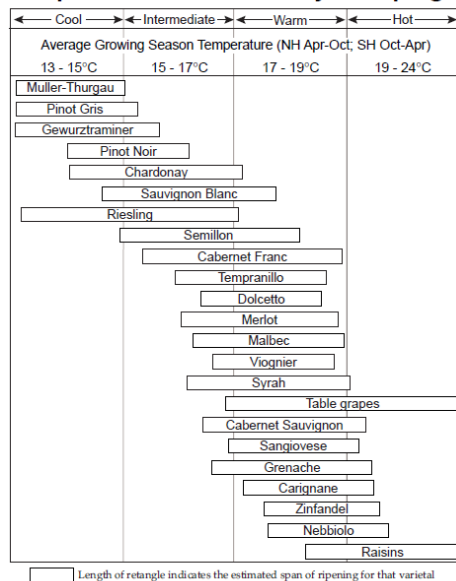
For most people the whole idea of having a vineyard revolves around what varieties to grow. It is an important decision with lasting consequences. No new grower wants to regret a choice five or ten years from now. There's no point in making a widget if there is no market for it and this principle applies to grapes and wine. This is always a source of anxiety when deciding exactly what to plant. There are three variables to consider: a) what you like to drink, b) what grapes/wine are selling best at this time (i.e., what the wineries want), and c) the grape that will perform the best viticulturally on a chosen site. In an ideal world, all three merge into one variety but there is usually some tension between them. The viticultural requirements are probably the most important, because it allows the best quality fruit to be produced, which will increase the likelihood of a buyer. Prospective growers must study the market closely by talking to local wineries and vineyards and finding out not only what is popular today, but what will be in demand tomorrow. If variety choice is being guided mainly by personal wine preferences, then the project is more likely a hobby and not intended as a commercial business.

Viticulture considerations

The important first step is to pick the varieties, clones and rootstocks that will perform best on your site. Such a list can be compiled by a viticulture advisor based on the soil and climate data from the site evaluation results.

Regarding climate, the vines must survive the winter and produce fully mature grapes on a consistent basis. Adequate cold hardiness is the most important factor in colder regions, followed by many other variables that impact quality and survivability. If winter injury is a potential problem, then the choice of varieties will be limited primarily to native and hybrid varieties. This can be a harsh reality for many people who enjoy drinking wines made from classic European varieties, but have a vineyard site that excludes these for one reason or another. Some forge ahead stubbornly only to suffer losses from winter injury or other problems. Nonetheless, it is possible that a balance of cold hardy and cold tender varieties can be arrived at that will satisfy both viticultural and marketing needs. Then, if a winter injury event occurs the cold hardy varieties will continue to generate revenues until the damaged vines can return to production.

Grapevine Climate/Maturity Groupings



Correctly matching variety to climate is critical to fine wine production (chart provide by Dr. Greg Jones, S OR University)

White wine grapes, especially among the hybrids and *vinifera*, are less finicky than reds, capable of higher yields, and will ripen in a wider range than reds. For example, Riesling can make a delicious wine at 19 brix or 23 brix. On either side of this ripeness spectrum there will be an acceptable wine style. But if Cabernet Franc only achieves 19 brix, it will produce a veggie wine that no one will like. In general, white varieties are less viticulturally demanding than red varieties. Ripening parameters such as available growing degree days, frost-free periods, and diurnal temperature variations (especially after veraison) will all contribute to the identification of the correct variety. Dr. Greg Jones, a climatologist at Southern Oregon University, offers a general illustration of the temperature ripening ranges of major *vinifera* varieties. Heat summation charts and USDA plant hardiness zones are other tools to help assign variety to site.

There are reasons why Riesling thrives in Germany, Cabernet Sauvignon and Merlot in Bordeaux and Napa, Nebbiolo in Piemonte, and Sangiovese in Tuscany, but even within these regions there are slight but specific differences in ripening characteristics. It is important to match the variety with the site's ability to fully ripen the fruit on a consistent basis. Look to climate data (particularly average length of growing season and growing degree days), neighbors' vineyards, other wine regions and other local sources of information to make correct selections. Daniel Roberts, a consultant in California, says that he tries to pick the coolest possible site that allows the grapes to consistently reach full maturity towards the end of the ripening season, allowing for full flavor and phenolic development. If a neighbor's Cabernet Sauvignon does not usually ripen until early November, that is a message that it may not be suited for your area. There are viticultural tools and techniques to compress a vine's vegetative cycle but it is wise to stay within a variety's natural ripening boundaries. In many cool to cold areas traditional and-or cold hardy hybrids are good and safe choices. They will ripen and survive the winter with greater certainty and provide a reliable product and income source. When necessary, blend variety selection with a foundation of "safe" varieties with more challenging varieties.

Climate is not always the determining factor in variety choice. Control of vine vigor is another important objective in Eastern viticulture, with the aim of getting the fruit and wood fully mature. On Long Island, where the climate is quite uniform on the North Fork, soil becomes the critical factor. Soil composition, whether it is sand or marl and clay, will inform variety selection, especially with red *vinifera* varieties, as will even small differences in topography.

Further important viticultural characteristics to consider are disease resistance, growth habit, vegetative vigor, fruitfulness, water and nutrient requirements (especially if dry-farming), and adaptability to the soil. *Vinifera* varieties are generally the most susceptible to disease and pests, more cold tender, and often have the longest vegetative cycle, making them more challenging to grow in a continental climate than their hybrid or native cousins. If sustainable or organic farming practices are a priority, then choosing the more disease-resistant hybrids makes sense. In a wet year they may only require half a dozen sprays while *vinifera* will need two to three times more treatments. In general, site requirements are more strict and narrow for the European varieties, so *vinifera* vines should be planted in the best sites and hybrids in the less favorable (but still good) areas.

The marketing conundrum

There is a common saying in the wine industry that goes, “People talk dry but drink sweet.” The market reality in Pennsylvania is that the majority of wines sold are semi-sweet to sweet. This is the wine consumer who comes directly to the winery door. In the city and among wine retailers, dry wines dominate, but at the moment most of the Eastern wine industry does not participate in this wine market. Sweet wines are derived primarily from native varieties such as Concord and Niagara and hybrids varieties like Baco Noir and Vignoles. These are extremely popular in tasting rooms and festivals, and reflect the realities of the retail customer base in the region. Dry wines made from *vinifera* varieties and the best hybrids like Chambourcin and Vidal represent a smaller wine consumer audience, but one that is growing rapidly. These are the wines that will garner the respect of the wine critics, restaurateurs and wine retailers whose stamp of approval is crucial to the wider recognition of emerging wine regions. With a few exceptions such as Riesling in the Finger Lakes or Merlot on Long Island, Eastern wine regions lack a varietal identity. This is due in part to the greater varietal diversity of the region, which many claim to be an asset while others are certain that it is a liability. Still, high quality wines of every type and style can be made and enjoyed by a diverse wine consumer audience.

Decisions regarding varieties, clones and rootstocks will depend on viticultural and marketing considerations, based on the site evaluation and the type, style and price point of the wines that your grapes are intended for. For example, viticulturally Eastern growers are at a disadvantage compared to colleagues in more arid regions, because they cannot field graft to change varieties (too cold and wet). On the marketing side, a clear understanding of the preferences of the target market is needed before deciding what to plant. If the wines are being made for sophisticated city wine drinkers, then *vinifera*-based wines are probably the logical choice. If you are catering to rural customers, your wines should tend towards semi-sweet or sweet hybrids and natives.

The quality of your vines

Some growers treat buying vines like going to the supermarket to buy milk. It is not and will never be that easy. Two of our region’s best wine growers said emphatically that the quality

of vine materials is one of the most important keys to a successful vineyard and that they would go to any lengths to ensure their vines are the best they can buy. Think of the plant as a cherished infant that everyone wants to be healthy and well cared for from the moment of its birth. In this analogy the plant nursery is the womb and a lot can happen there – good or bad – before the vines are delivered to your farm. The long-term productivity and quality of your vineyard depends on the quality of the vine materials you use, but procuring the best plant materials is not an easy task, especially if you are looking for unusual clones and rootstocks.

To begin with, it may be hard to tell whether a vine is healthy or not. As with soil, what is not visible can be extremely important. In grapevines a complex of virus and fungal diseases can affect the woody parts of plants and they are often propagated and disseminated in grape nursery stock. Major fungal pathogens of grapevines in the East include *Eutypa*, crown gall, tomato ringspot virus, leafroll virus, grapevine yellows, and Petri diseases, all of which can cause vine death. Vines often come “pre-loaded” with pathogens, which lay dormant until some environmental cue such as a stress (winter injury, water stress, mechanical injury, etc.) triggers the symptoms. All of these maladies can lead to lower quality fruit, lower yields, and even premature vine death. Young vines are almost always more susceptible to pathogens than mature vines. Growers must protect and nurture their vines into maturity, when they will be more tolerant and resistant to problems. The nurturing process begins by sourcing clean plant materials; then getting the vines established and into production with a sufficiently strong root system and vine structure to overcome biological and environmental threats.

How do you get a clean vine? There are currently vine certification systems based in the states of California and Washington that serve the wine industry. The Foundation Plant Service (FPS) run by the University of California at Davis imports new desirable varieties, either for private growers or for public use. The plants are run through a rigorous quarantine and testing process to identify any problems, using sophisticated methods such as ELISA and PCR and a traditional practice called woody plant indexing. The Northwest Grape Foundation Service also provides clean and tested plants to nurseries participating in a certification program.

Clean vines are created using shoot tip tissue culture. They are then planted in a foundation block, which is strictly managed and monitored to be pathogen-free. To satisfy industry needs for a new variety, cuttings can be moved to an increase block in order to “blow up” materials to commercially viable amounts. Certified cuttings are then delivered to approved commercial nurseries that keep their own sanitary and increase blocks to generate materials for commercial distribution. Vines can be tested by foundation services and labeled as certified, but this does not mean that they are sure to be free of all problems. They are less likely to have any of the pathogens designated on a list approved by the state Department of Agriculture. It is not a guarantee of total cleanliness. Instead, it assures the user that careful monitoring of nursery blocks is being performed. Conversely, a vine that is uncertified does not necessarily imply that it will be loaded with disease.

The commercial grapevine supply system is constantly being challenged by the incursion of known and unknown plant pathogens. Vines with problems are finding their way into vineyards. Every precaution should be taken by commercial growers to assure sanitary conditions at their vineyards and clean plant materials from nurseries. Unfortunately, many new varieties and clones are either not available as certified vines, or only from California nurseries. Certified vines are more expensive, but considering the cost of losses in uniformity and production or the costs of replanting, they are worth the higher price. FPS and NWGFS are suppliers of certified materials either directly to growers or via cooperating nurseries.

Investigate their lists and find out which commercial nurseries stock their certified vines. At the time of this writing, a consortium of Eastern universities, state and federal agencies, nurseries and industry associations are working to create a regional foundation plant service that will provide clean vine materials to the commercial grape industry in the East.

Regardless of variety, when dormant vines arrive from the nursery they all look alike. Unfortunately, it's impossible to look dormant nursery stock and determine its varietal identity. That is why time must be invested in developing a relationship with a nursery can be trusted. Planting a mis-identified variety is not a good way to start a vineyard. There is genetic technology available to correctly identify some varieties and the genome has been mapped in Pinot Noir (2008), but for all practical purposes a vine's identity is unknown until it produces identifiable fruit and leaves, usually in the second or third year. The tag attached to a bundle of dormant vines is not assurance of true-to-type. Growers can only hope that the nursery sent exactly that what was ordered and that none of the bundles get mixed up on the way to the field.

There is a science of plant identification by anatomical and morphological features called ampelography but it not widely known or practiced. It is difficult at the variety level and even more challenging when identifying clones. Dr. Andrew Walker at UC Davis and Lucie Morton in Virginia are two of the best in the U.S. It is also necessary to correctly identify rootstock varieties. If you suspect that Pinot Noir is Gamay, or Pinot Blanc is Melon, or SO4 is really 5C, you may want to bring in an expert to make a positive identification.

Using suitcase or bootleg material from anywhere outside of the U.S. is not only a stupid idea, it is also illegal. Smuggled materials can bring diseases, viruses or insect pests into vulnerable vineyards. Before the dangers of pathogens were fully appreciated, phylloxera and powdery mildew, which are indigenous to Eastern North America and are two of the worst scourges in viticulture, were exported to Europe, and then California with devastating effects. There is a formal procedure for importing grapevine materials into the U.S. It is expensive and time-consuming, but really the only way for you to get new varieties into the U.S. and also keep our plant material resources secure. The USDA Animal and Plant Health Inspection Service (APHIS) works with FPS and Cornell University to import plant materials. Private growers can contract either service to bring in new varieties through their quarantine system.

What constitutes a healthy plant? These criteria should be met:

- Certified root and scion stock (vines come with certification tags)
- #1s or super-premium stock
- One-year-old plants only
- Minimum 3/8" to 1/2" caliper for rootstock and scion (match diameters)
- Minimum 2-bud scion
- Scion angled at 30° or less
- Adequate number, length and quality of roots, evenly distributed around the base (i.e., not all on one side). Diameter 1 mm to 4-5 mm.
- Thumb test on graft union and overall quality of the graft. Look for 100% union with no cracks or crevassing. Take the tip of the scion in your left hand and the rootstock in your right, and bend the plant up to 30 degrees to see whether it snaps or if you can feel any give in the graft union.
- Uniform size of vines, roots, etc.
- Paper trail documenting the type of variety, clone and rootstock
- Quality of storage and delivery conditions

In the past, most growers propagated their own vines, even bench grafting plants for their vineyards. But now growers are not encouraged to graft and/or root their own vines, because it is so difficult to control quality and quantity in a non-commercial nursery setting. Bench grafting requires the proper tools, skills and facilities, and this is not an area in which a serious commercial vineyard should try to save money.

Hybrid varieties are designed to provide useful viticultural characteristics such as cold hardiness, shorter growing season or disease resistance. Recently, advances in breeding for cold hardiness have opened up colder regions to fine wine production. The University of Minnesota has released both red (Marquette and Frontenac) and white (La Crescent and Frontenac Gris) varieties that are already experiencing commercial success. Elmer Swenson, a grower and grape breeder in Wisconsin, developed a long list of hybrid varieties, many of which are now being grown commercially. These vines can survive to temperatures below -30° F and do not have to be buried in the winter. They tend to show greater disease resistance and their vegetative cycle is shorter than other hybrids and *vinifera* varieties. They are quite recent arrivals, however, so the optimal viticultural practices (such as trellis and training systems) for them are not yet fully understood. It would be wise to taste their wines before planting them.

Traditional inter-specific (French) hybrids such as Vidal Blanc, Seyval, Chancellor, Marechal Foch, and Chambourcin can make wonderful wines, often better than their *vinifera* cousins in some locations, and they may be especially well adapted to blending with *vinifera* or other hybrid varieties. Varieties developed at the New York State Agricultural Experiment Station in Geneva such as Cayuga White, Traminette, and Noiret have been successfully established as commercial wine varieties. Native varieties like Concord and Niagara still form the base of wine production in the East and can make very fine wines for summer sipping. They meet popular taste and can also be grown in colder areas.

Rootstocks

Rootstocks are one of the more mysterious aspects of viticulture, but they are crucial to fine wine production. Although out of sight, they should not remain out of mind. Unlike the variety or clone, rootstocks do not have a direct influence on wine characteristics such as color or flavor, but their indirect effects can have a significant impact on quality. They may be the most under-utilized, under-appreciated, and yet critical viticultural tool available to wine growers. Rootstocks can determine the survivability of your vines and the ultimate quality of the wine they produce. Their main purpose is phylloxera resistance but they can also influence vine size, the vegetative cycle, and adaptation to the soil chemistry and physical characteristics of the site. One of the main objectives of any site evaluation is to provide the information necessary to make the correct rootstock assignment.

Rootstock numbers can be confusing but they are important and you should take time to become familiar with the primary commercial wine rootstocks. The default rootstock in the East is 3309C. It grafts well, is widely available, typically demonstrates moderate vigor, and is reputedly resistant to some nematodes. However, it is not always the best choice. New growers should investigate the wide range of rootstocks available and the viticultural characteristics of each that could enhance grape quality. Eastern soils are generally fertile, cool and humid, so a rootstock like Ripara Gloire or 101-14 might be selected to exploit or mitigate these conditions. There are many other rootstocks to choose from, but we still lack experimental data on which ones may be more suitable for a particular soil or area. Some very good rootstock work has been done by Dr. Terry Bates at Cornell University in Western New York, comparing rootstocks,

varieties and soil pH. He has demonstrated the influence of rootstocks on vine balance and its implications for wine quality. While most rootstock information originates from California or Europe, eventually broader trials will provide Eastern growers with the data they need to understand regional rootstock performance. For the present, carefully study the data and characteristics from other areas and meet with local growers who have tried different rootstocks in order to determine what will work best on a particular soil and site.

Rootstocks are important for their viticulture effects, but their first duty is to protect the grapevine from soil-borne diseases and pests. In the case of *Vitis vinifera* the primary enemy is grapevine phylloxera. Take the time to learn about this root louse, which has done more to change the face and economics of the wine industry than almost any other organism. All *vinifera* vines must be planted on phylloxera-resistant rootstock if they are to survive and produce fruit. Most inter-specific hybrids with *vinifera* parentage such as Traminette may benefit from being grafted onto phylloxera-resistant rootstocks. In addition, some rootstocks offer resistance to certain nematodes, which can help to prevent the spread of some grapevine viruses, although the expression of this phenomenon in the East is not yet well understood or documented.

Rootstock can offer other features such as a greater tolerance of drought, wet soils, lime and low pH soils. Some impart to the scion an indirect effect of lesser or greater vine vigor, which can affect the vegetative cycle of the vine. This is a major asset in high quality wine production in cooler climates when limiting the vegetative cycle of the vine is an important viticultural goal. A rootstock like Riparia Gloire and its clones, or 420A and 101-14 can regulate vine size and indirectly promote fruit maturity. In a wet, cool climate a few days may mean the difference between harvesting grapes before or after a significant weather event, which can have a dramatic effect on quality. When they are mixed and matched with the soil attributes, a balanced, well-adapted and healthy vine that produces better fruit than an own-rooted vine may be attained.

Proper rootstock assignment is not for the amateur or novice wine grower. The viticultural conditions and goals for the wine must be clearly understood if a rootstock is to make an imprint on a wine. A viticulture consultant familiar with who rootstocks perform under local conditions is almost a necessity to achieve successful results. Nursery websites contain good information and there are also some reliable reference books (see information resources). However, the best source of information on actual performance will always be the local growers, who should be tapped for their knowledge.

In California the practice of field budding onto a rootstock that was planted the previous year is widely used. Field grafting and budding are difficult in areas with rainy spring weather.

Rootstocks for Grapevines

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Key principles:

- 1) Rootstocks provide protection against pests and diseases in the soil
- 2) Vine vigor and size relate to site capacity, management practices, and grapevine variety
- 3) Rootstocks are a management choice that can only be made once
- 4) Characteristics of rootstocks reflect their selection criteria

Rootstocks were first used for grapes because of phylloxera, a root-feeding aphid. Phylloxera can kill grapevines of the species *Vitis vinifera*. Phylloxera resistance is still the most important aspect of a grape rootstock. Pest and disease resistance provided by grape rootstocks is the central reason that we use them.

The rootstock is the primary interface between the scion variety and the soil, moderating the interaction between them. Rootstocks take up water and nutrients and provide them to the scion. The rootstock influences the scion through increasing and decreasing scion vigor and vine size (among other influences). One goal of the grape grower is to promote sufficient growth of the scion in order to reliably produce a suitable and sustainable crop. Too much growth and the vines can be difficult to spray, pick, and prune. Not enough growth and the vine may fail to adequately ripen the crop. The goal is to reach a "just right" level of vine vigor and size.

We have only one opportunity to choose a rootstock for the vineyard, so in selecting a rootstock we should focus on the key contributions that rootstocks make. Many management practices can be changed from year to year – for example, we easily can install irrigation, modify fertilizer applications, and adopt new approaches to vineyard floor vegetation management. It is even possible to change the trellis and the scion variety. As a guiding principle, rootstocks should be used for those things for which the cultural practices are expensive, impractical, or unsustainable. For example, many rootstocks provide protection against phylloxera. We would use these rootstocks instead of other management practices such as winter flooding. Rootstocks are an appropriate management tool when used correctly, but we need to recognize their limitations. Rootstocks can be a blunt tool; for example, increasing or decreasing vigor is much easier to fine tune through irrigation than through rootstock variety.

Vineyard sites and rootstock varieties come in a range of vigor capacities. Since the site and the rootstock in turn influence the scion, the site should be considered when selecting a rootstock. Characteristics that influence site vigor include effective rooting depth, soil chemistry, soil particle size, slope, water holding capacity, drainage, precipitation, climate, and site history. Management practices that influence the site's contribution to vine vigor and size include irrigation, fertilization, weed control, and structural modifications (such as ripping). Rootstock features that influence vine vigor and size include root architecture and distribution, drought adaptation, nutrient uptake, and even the resistance to pests and diseases. Training and trellising can help to direct the scion growth that results from a particular site and rootstock. Growers should take into account the contributions of rootstock, site, and management practices when choosing a rootstock. Complement the contributions of the site and management practice with the rootstock that you select – management practices can be changed, but the rootstock choice is with you for the life of the vineyard.

Understanding the capabilities and limitations of rootstock helps us to choose appropriately. We can use information about a vineyard site, management practices, the natural habitat and environmental adaptation of grape species, and selection criteria for grape rootstocks to guide us in deciding which rootstocks would be suitable for a particular vineyard.

Clones



Variety: Merlot, clone 343 on Slate Quarry Riparia rootstock

Sometimes it seems that the only thing modern wine makers want to talk about is the latest and greatest clone of this or that variety. There is a widespread conviction that clones contribute crucially to wine quality. With arcane names like Swan, Wente or Martini, or numbers like FPS 4, Dijon 667, or UCD 108, the clonal landscape can be very treacherous and confusing. Yet having the clones that winemakers favor or that offer the best viticultural performance on a site could be vital to grapes sales and wine quality.

It is often hard to measure a clone's contribution to the overall quality of a wine. Many growers claim that site expression trumps any discernable clonal effect. However, a few examples in Oregon help to demonstrate the importance of clones. When David Lett brought the Pommard and Wadenswil (from France and Switzerland respectively via the Foundation Plant Material Service at UC Davis) clones of Pinot Noir with him to the Willamette Valley in 1968, they proved to be the perfect pair for the soil and climate of this new wine region. Pommard with its smaller clusters produced rich, dark wines, while Wadenswil offered lighter style wines with fresh and bright berry flavors. The two clones helped to put Oregon on the world wine map and continue to do so. With Chardonnay it was an altogether different story. Clone 108 (UCD 4) is a large and tight clustered clone of Chardonnay that was meant for warm growing regions. In the Willamette Valley it rarely ripened fully and often yielded wines with aggressive acidity and tart flavors. Oregon, a cool region that should be ideal for growing Chardonnay, never gained favor with wine consumers for this noble variety and, to this day, Chardonnay languishes in the shadow of Pinot Gris.

The choice of clone can make a difference, particularly for “terroir” varieties like Pinot Noir, Sangiovese, and Nebbiolo. Winemakers now fuss over Cabernet Sauvignon and Merlot clones, almost as if there were a “Clone du Jour.” In Bordeaux, the search for a better clone of Cabernet Franc continues. Many chateaux, often impatient with government clonal research, have their own clonal selection programs. When considering what varieties to plant, be sure to research what clones of each variety are available and how much difference they will make to quality.

It is difficult to determine how much the clone contributes to quality on any given site in comparison to other viticultural attributes such as rootstock, viticulture practices, soil and climate, etc. Clones are definitely one component, but their impact will be influenced by other variables. If they can make a difference to quality, then it is worth pursuing the correct clones. If the difference is negligible, then this parameter should not be overemphasized. Information about clonal performance can be collected from neighboring vineyards and trials conducted at viticulture research stations. In the East, Cornell University's Long Island Horticultural Research and Extension Center has a long tradition of evaluating *vinifera* clones. At the present

time, clonal selection is applied only to *vinifera* varieties and some rootstocks. Hybrid and native varieties are not propagated by clonal types.

The nursery

Once the varieties, clones and rootstock have been chosen, it is necessary to find the right nursery to supply them. The commercial grapevine nursery landscape is a minefield, so growers need to proceed cautiously or else the long-term health of the vineyard may slip out of control. Nurseries may be big or small, good or bad, they may have what you want or not, and all of these variables could change from one year to the next. Buying grapevines is not like going to Walmart to buy clothing or a television. There is not built-in uniform consistency and quality of product. Nurseries are also subject to the weather and quality control issues. Some perform consistently better than others. Any nursery order begins with a visit to the nursery's website or better yet, to the nursery itself. The nursery will usually provide ample information on its varieties, clones and rootstocks, but qualitative assessments are more difficult to make. Grower referrals are valuable but not conclusive. Check with local growers about which they like and the quality of their materials, the success rates of newly planted vines, disease or virus problems experienced, mix-ups of variety types, etc. It is also important to know who the best nursery sales representative is and to discuss your order with him or her directly.

Eastern grapevine nurseries tend to be smaller than their Western counterparts and they understand the region's growing conditions and vine material requirements better. However, they sometimes do not have the latest *vinifera* clones and rootstocks. Western nurseries, which supply large vineyards with tens of thousands of vines, on the other hand may not give a small order from the East quite as much attention as it deserves. The best hope for consistent quality is to develop a relationship with the nurseryman so that an order is not just a number on a piece of paper. If he senses the grower cares about the quality of the vines, the outcome will be more likely sound plant materials. If you are placing a large order, one or two visits to the nursery at key production moments like grafting and digging to check your vines may be a good investment. Inquire into the nursery's practices and facilities, get to know the nurseryman, ask good questions and verify the stock from which your vines will be pulled. The source of rootstock and scion materials is vital to the soundness and correctness of the plants that will fill an order. If wood is harvested from a "dirty" vineyard, then it likely to be spread to other vineyards, even if the plants are certified.

A lot of time, money and effort is invested in evaluating a site to decide exactly what to plant on it. The decision is made to plant variety X on clone Y and rootstock Z. At this point, if the nurseryman says he does not have clone Y on rootstock Z, and only #2s, the prudent decision is to wait or walk. Do not let a nurseryman who has never seen the vineyard site decide what variety, clone or rootstock will be planted. Never compromise the integrity of a vine order based on availability. If a careful site analysis determines that Cabernet Sauvignon 337 on Riparia Gloire will make the best wine then that is exactly what needs to be planted. If Nursery A does not have it, then go to Nursery B and on down the line. If no nurseries have it then, do the hardest thing in the world for a new grower to do. Wait another year. Nursery production is guided by pre-orders of grafted vines, but most will produce a certain amount of "spec" materials for the spot market. The vineyard is a 30-year plus project and it took a lot time and effort to decide what will be best for it, so don't rush to plant or let an unknown person (often a salesperson) dictate the future of the vineyard. It will handicap the wine by not getting the right and best vine materials from the start.

Nursery orders are generally placed the year prior to planting for own-rooted vines and 18 to 24 months ahead for grafted vines. In the cycle of grafting, a nursery cuts the rootstock and scion wood in the winter. It is then grafted and callused and in the summer planted in the fields to grow and establish roots. The vines are dug in the late winter and early spring, sorted and packed for shipping. The success of grafting varies with variety and rootstock type. For example, the rootstock 420A is notorious for its difficulty to graft. Therefore, a percent of above the needed number of vines should be ordered to account for failed plants in the field. Only the nursery's highest grade of plants, usually called #1, should be ordered.

The quality of plant materials from commercial nurseries can be maddeningly uneven. One year Nursery A will deliver pristine vines and Nursery B will be awful and the next year just the opposite may happen. Growers will sometimes feel frustrated in their efforts to source clean, healthy vine stock. As a precaution and especially with larger vine orders, purchasing materials from two or more nurseries may offer some protection against large-scale failure in a new planting. Then if there is a major problem with one block from a specific nursery but not another, the nursery can't accuse you of incorrect vine handling and/or planting. No matter whom you are dealing with, make sure that you have a vine contract which spells out your order in precise detail so everyone – before, during and after the order is processed – knows exactly what was agreed upon. Typically, a nursery will expect one-third payment on signing the contract, another third at grafting, and the final third upon delivery.

Next to the cost of the land, the vine materials are often the most significant vineyard development cost and one with serious implications for quality and profitability. A grapevine consultant could help in your quest to secure high-quality vine material. If you are a small vineyard in Pennsylvania ordering 5,000 vines from a large California nursery that is grafting several hundred thousand plants for Constellation or Fosters, it's not hard to guess where your vines will fall in the pecking order. And yet you care as much about the quality of your vines as the big guys, maybe even more. How can you make sure that your vines are as good as theirs? There are consultants who will help you to monitor the entire production process, following "your" vines from bud wood and rootstock sourcing and selection to grafting to digging and shipping. You will be incurring extra expenses, but according to some of our best Eastern wine growers it will be well worth it in the end. In today's high density vineyards the vines are likely to be the most expensive part of a new vineyard project, excepting the cost of the land, so it is well worth protecting this investment with some additional knowledge and care.

Nurseries and Vine Material: The Pursuit of Quality and Healthy Vines

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After site selection, soil preparation and block design, the selection of healthy rootstock and scion clonal materials is paramount for assured vineyard longevity and uniform productivity. Independent pathogen testing of California State-certified propagation materials has shown that rootstock and scion tissues are routinely contaminated with economically important grapevine virus, fungal and bacterial pathogens. Contaminants routinely found in certified stock include Grapevine Leafroll-associated viruses, Corky Bark virus, various fungal pathogens and tumorigenic strains of *Agrobacterium vitis*.

The importance of plant material in establishing a vineyard seems obvious but is often understated. Growers and wineries may pay handsomely for consultant advice regarding site selection, soil preparation and rootstock choice, but leave the physical status and pathogenic condition of the planting stock to grapevine nurseries that specialize in moving thousands of units rather than in the quality characteristics of individual plants.

Most grapevine plants destined for vineyard establishment in the United States are propagated in California. California nurseries voluntarily work with the CDFA Grapevine Nursery Certification program that has oversight over the pathogenic quality of vines leaving quarantine at Foundation Plant Services, UC Davis, prior to propagation at state-certified nurseries. Regulations currently in place were established more than 20 years ago, when use of forgiving rootstocks such as AxR #1 and St. George were the norm. Since the early 1990's when *Phylloxera* prompted massive replanting in California, a wide range of European rootstocks that are less tolerant of the fungal and viral pathogens now detected in certified stock have become popular. Because of the prevalence of unclean planting material in California nurseries, careful selection of nursery and vines is becoming increasingly important.

Whenever possible, visit nurseries before placing orders. If the nursery looks clean – i.e., asphalted surfaces abound, materials and worktops are frequently washed down – then there is a greater likelihood that vine products will be "cleaner".

Ask whether the nursery has recent independent test results on the virus status of the rootstock and scion mother blocks selected for your order, and whether the mother blocks to be used belong to the nursery or third parties, and whether the scion materials are certified. Talk to prior nursery customers to gauge their level of satisfaction.

If the nursery is producing vines on a custom basis, inquire as to the overage to be grafted. Try to be present at the time of propagation to ensure that the correct clones are used, and ideally you should examine the vines in the nursery twice during the growing season – whether it be potted vines for early summer or dormant benchgrafts for the following March-June planting period. Examination of vines during production allows for the early detection of physical imperfection and permits you to gauge the likelihood that a sufficient number of high quality vines will be available at harvest to meet your order.

Make a nuisance of yourself and frequently ask the nursery how the vines are progressing and note down expected harvest dates. If possible, arrange to visit the nursery at harvest and pay attention to the quality of the vines being packed for your order. Evaluate the external condition of vines for imperfections and their internal condition for symptoms of stress and disease. Establish a firm date for product delivery and read the small print on the back of the contract carefully – customers normally have 48 hours to inspect vines and reject substandard material. Stand your ground with the nursery and insist that materials which appear to be unacceptable are unacceptable. If necessary, hire an independent expert to help evaluate delivered vines, but it is preferable to hire a consultant before placing your order to ensure that all steps in the propagation process are undertaken competently with high-quality, pathogen-tested materials.

Chapter 12

Vineyard Design

One attraction for people who love wine is the sheer pleasure of contemplating a vineyard with its neat, orderly rows of closely trimmed vines. The casual observer will not see all of the complex decisions that went into making the vineyard look the way it does. For example, why are vine row direction and length so important to the vine, vineyard efficiency and wine quality? Design must be a blend of the practical, the functional and the aesthetic, with the emphasis on those factors that will improve viticultural performance and the efficiency and ease of all vineyard operations.

In general, vineyards need to be more intensely designed for *vinifera* varieties and especially the late ripening ones than for natives or hybrids, which are more forgiving and can make good wine over a wider range of grape maturity. In designing a vineyard, not all varieties should be treated in the same way. Red or white, variety and species – each has its own needs. *Vinifera* varieties will be comfortable on a vertical shoot position system at higher vine densities, while hybrids thrive on a high-wire system at lower vine densities.

Conceptualizing the vineyard design should start the moment you begin to evaluate a piece of property as a vineyard site. Mike Walsh, one of the reviewers of this manual, has described how he will spend hours sitting at various vantage points on an undeveloped site imagining how the vineyard might come together. He uses his sketches and notes as the basis on which to formulate a vineyard plan. Of course, this method is only possible because of Mike's years of experience installing vineyards in California. Preliminary planning is even more important for complicated topographies and soils. The vineyard designer is immediately faced with variables such row direction, block sizes and shapes, slopes, aspects, etc. Large, flat, single blocks of vines are ideal for vineyard operations. Two of the best wine regions in the East, the Niagara Peninsula and Long Island, enjoy a fairly uniform topography and produce very fine wines. Hilly sites are more challenging to develop and farm, but can offer highly distinctive wines.

Vineyard design is strongly influenced by the type of wine the vineyard is intended to produce and the results of the site evaluation process which estimates the site capacity, potential vine size and the parameters necessary to achieve vine balance. These factors may be known by looking at your neighbor's vineyard, otherwise, your design is the best educated guess based on the available information you have collected and the intuition of experienced advisors.

Design parameters: Reconciling effectiveness with site factors

There are certain objectives that a good vineyard design must try to reach, including minimizing soil erosion, using land efficiently, facilitating all aspects of vine management and equipment operation, optimizing variety and rootstock performance (taking into account the soil, irrigation systems, and mesoclimate influences such as frost, freeze, wind direction, and other potential threats), and maximizing vineyard access, safety, and other considerations (including aesthetics) that will be unique to your property.

Topography will be a crucial factor to any design. A flat surface, even if sloped, is easier to work with than rolling, sloped surfaces. When planning a vineyard, safety should be a primary concern. As a rule a vineyard should not be designed around the dimensions of farm equipment – as tempting as this may be, the result is likely to be an immediate and permanent

compromise to potential wine quality. Operational efficiency must be incorporated into the design. All of these decisions must be blended with the ideal viticultural design for the site.

Much of the viticulture component of vineyard design will depend on the wine that is expected to come out of the vineyard (white or red), yield expectations, and style and price point objectives. High-quality red wines tend to be the most demanding and this will be reflected in the design and costs of the vineyard. In a mature vineyard the price point of the wine will influence how much viticulture (i.e., all the necessities for high-quality vineyard management) can be purchased (see economics in Chapter 8).

Once the site evaluation is completed, a map should assign potential vine vigor to various sections of the vineyard. Vine vigor will influence the choice of trellis system and vine density. The map will also play a central role in the design process, influencing not only the assignment of varieties and rootstocks but also block design and location. Once you have chosen your varieties, clones and rootstocks (as a function of the climate and soil characteristics of your site) you will have to decide where to plant them. It isn't quite as easy as saying, "High value reds should go on the top of the hill where the soils will probably be lighter, warmer and further from frost," and "Cold tolerant white varieties such as hybrids should be planted at the bottom of the slope where soils are deeper and more fertile and cold air will tend to pool" but general rules such as these apply to most vineyard sites. These decisions must be integrated with row direction and block size and shape.

Even with all the careful planning vineyards their first iteration are a bit of a shot in the dark. If luck prevails the vineyard delivers on most of the expected results. But almost certainly within ten years the observant grower will have completely redesigned the vineyard in his mind and be awaiting the opportunity to tweak the original concept. Jim Law at Linden Vineyards is an excellent example of a grower who over the course of 25 years has learned every nuance of his vineyard and is slowly tailoring it to achieve the proper varieties, rootstocks, spacing, vine density, trellis and row direction. There is no substitute for this kind of experience, based on careful observation and endless tinkering. A vineyard continues to express itself over time. It is a living and dynamic organism that is constantly changing and the shrewd growers learns from it and is constantly making adjustments to improve quality.

Time is money, so the design should incorporate the best and most efficient practices into the vineyard from the outset. Jan Waltz, a grower in Manheim, has learned over time that it takes him 50% longer to cover a block with his sprayer if it is planted with short instead of long rows due to the extra turning required. Any time spent turning a sprayer with the nozzles off is time lost. Point blocks, where rows decrease in length to a point, should be avoided as they are expensive to develop and inefficient to farm. Try to maximize row length and minimize row number to the extent that soil changes and uniformity will allow. Flat, square fields are the easiest to farm but do not always offer the best terroir for wine.

Other considerations that will affect your design are fencing, irrigation and drainage systems, and other infrastructure such as roads, buildings, and work areas. All of these have specific design and space requirements for their construction and use that may impact on other vineyard design considerations. They must be integrated into the vineyard plan in such a way as to optimize efficiency and performance and not hamper your viticultural imperatives. Headlands and alleyways around and between vineyard blocks should be incorporated to furnish plenty of room for equipment operation. The standard is 30,' and perhaps more if a mechanical harvester is used. Access roads and workspace are also important. Imagine where a flat-bed truck or

semi-tractor trailer can be loaded and turn around with a load of grapes, and then work it into the design plan.

Designing your blocks: Row direction and other considerations

Row direction is a crucial design feature that will be difficult to change at a later stage so it deserves careful consideration. It will be influenced by many local factors, especially topography and orientation to the sun. For the sake of uniformity it is desirable to attain equal sun exposure on both sides of the canopy. A flat field, even if it is on a slope, has the most potential for correct row direction. East-west rows tend to ripen (and sunburn) fruit to a greater degree on the south-facing side of the vine. The option on E-W rows would be to harvest the south and north sides of the vine separately. In the East, north-south rows are preferable in most cases to attain equal sun distribution on the canopy. The sun is usually less intense in the morning than in the afternoon. Some growers are tilting rows 10-20 degrees towards the northeast-southwest to obtain more direct sun exposure on the east side in the morning and a cooler aspect in the late afternoon and evening.

The question of row direction on slopes is constantly debated and compromises usually prevail. In the great wine district of Piedmont in Italy, rows run across the hills. In Germany, rows run up and down the hills of the Rheingau with some exceptions found on terraces. A south slope with rows running up and down is ideal, but there is greater risk of erosion. Going across the side of the hill makes equipment operation more risky, especially under wet conditions or when using an implement such as a hedger, which raises the tractor's center of gravity. The narrower the rows and the tractor, the more top-heavy the latter becomes. Planting across the hill may also create terracing effects, further complicating tractor operations as well as control of the area between vines and the inside row on a terrace. However, terraces tend to hold soil moisture better than a flat slope. In all cases, cover crops will probably be necessary to hold the soil in place.

Terraces look spectacular and capture the imagination of wine lovers. Often the most dramatic vineyards are on steep terraces that rise above a river such as in Ribeira Sacra in Spain, or Hermitage in France, or the Mosel or Rheingau in Germany. These are the vineyards that leave a permanent imprint on people's minds. In some cases terraces may be the only practical way to reclaim steep land for vineyards but they are difficult and expensive to develop and farm, inherently inefficient, and usually dangerous. It may be best to leave the terraces to those who have spent generations farming them.

Aspect or slope orientation depends on many factors. As a general rule, south slopes are preferred. In Piedmont there is even a specific word, *sori*, used for a hill with a south exposure. A traditional method used by growers for centuries to identify potential vineyard sites is to note where the snow melts first on the hills, and these will usually be on a south slope. The Romans, as they marched north through France and Germany, always looked for south slopes – for example, the bend in the Rhine River that now forms the Rheingau district, home to the great Riesling wines. This aspect captures the light well and allows for north-south rows running up and down the slope. As a variety reaches its climatic ripening limit, a south exposure becomes even more preferable.

A west or east slope will require north-south rows to run across the hill, a practice in used in Piedmont. A north aspect is generally not favored, except in hot climates or to take advantage of natural protective features (for example, Lake Ontario for Niagara Peninsula growers) or to mitigate the effects of sunlight on certain varieties, whites in particular. Aspect and slope can be

important to vine survival in cold climates. Vines on south slopes may de-acclimate from their cold hardy condition during unseasonably warm days and be more subject to freeze injury as a result. This is yet another risk factor that needs to be taken into consideration when designing a vineyard.

In a humid and wet climate like the East wind can be a desirable ally against disease. A breeze that can help dry leaves from morning dew or an afternoon shower is an important supplement to any integrated pest management program. While evaluating the row orientation for different sections of the vineyard, take into account the wind and its prevailing direction and force. There are some growers who will choose a row direction for optimal wind circulation over sun exposure. However, excessive winds can also inhibit photosynthesis (by causing the leaves to shut down to avoid water stress) and interfere with important activities such as spraying.

Row length will vary according to the site features, but up to a certain point longer rows make for more efficient vineyard operations. Jan Waltz explains that it takes 45 minutes to cover blocks with 500' rows and 75 minutes to cover the same acreage with 200' rows. Long rows are also the most cost-effective to develop. Other viticulture texts state that 500' rows are the longest practical length. Runs can be longer if the topography allows, but should be broken up by alleys to allow crews and equipment (especially sprayers and grape bins) to enter and exit the field, or to accommodate changes in soil (and possibly variety and rootstock). Long rows also affect the field worker's morale, as he could become discouraged working on a single row for a long period with little perceptible progress.

Blocks should be designed for uniformity in vine size and balance, synchronicity in fruit ripening, and optimal vine and equipment performance. Things to avoid are: swales and other low, wet spots; overly steep slopes, woods; northwest to northeast slopes; areas that will be too hot or cold; fields surrounded by other agronomic crops (to avoid herbicide drift); sites near schools, businesses, and subdivisions; and soils that are too fertile.

At the end of the design process there should have a detailed map of the vineyard, indicating where every single vine (designated by variety, clone and rootstock) will be planted, as well as the vine density, trellis and irrigation systems, etc. This will serve as your road map for the rest of the development process.

Site capacity and the balanced vine

A site has the capacity to produce a vine of a certain size that will be in proper balance. The job of the grower is to determine this size and create a balanced vine. A balanced vine has the best potential to produce high quality fruit. A simple illustration is the difference between a vine in California and Bordeaux. In the San Joaquin Valley Thompson Seedless vines on 100 ft² (12' x 8' spacing) of fertile soil can produce 50 pounds of fruit. In Bordeaux vines grow on 10 ft² (meter by meter) producing about 3 pounds of fruit per vine. Why is there such a dramatic difference in density and yield? Site capacity is a term used to describe the relative 'strength' of a soil as a function of its soil moisture-holding capacity and fertility. Strength is "the ability of a vineyard site to support vine growth and fruit production" but does not imply that a strong site is necessarily a good one. In general, the goal should be to plant the highest possible density that will create and maintain vine balance. Natives and most hybrids can bear heavier crops than *vinifera* varieties and make the quality grade of fruit expected of them, but high quality hybrids like Vidal and Chambourcin may benefit from crop regulation and tighter spacing. Site capacity, to some extent, will determine the type and style of wine that can be grown. Keep

these relationships between variety, balance, and density in mind during the vineyard selection and planning processes. Unfortunately, the only practical way to determine a soil's true capacity is to plant vines in it and see what happens. The first viticultural use of a site is always the most revealing, but since vineyard projects are so expensive and enduring, every effort must be made to achieve balance from the beginning. Any adjustments made post-planting amount to the band-aid viticulture that growers should try to avoid. In essence, each new vineyard is an experiment and the quality of vine and fruit is the data to be collected and interpreted.

Site capacity should inevitably influence the type, style and price point of the wines produce on the site. The variables (soil, climate, rootstock, etc.) that contribute to vine balance do not always correlate according to a plan, so caution must be exercised, especially in the case of new vineyards. A high capacity soil is not well suited to produce luxury quality red wines, but nor is a depleted soil capable of producing high yield production wines. Generally, increasing the vine density for red wines appears to improve wine quality. Once again, it is emphasized that the terroir conditions should be closely matched to the intended wines.

Vine density and spacing

Distance between rows determines quantity. Distance between vines determines quality

Daniel Roberts, Integrated Winegrowing

This bold, yet simple statement applies to many premium-quality wine vineyards. Balance, harmony, equilibrium, and uniformity are words that free-associate well with correct vine density and spacing that encourage a balanced vine. But harmony is hardly the term that would describe the heated debate among viticulturists on this topic. Whether referring to a big vine growing on 100 ft² or a small one on 10 ft², we want to keep these adjectives in mind when

we look at and measure vines. Yet there is little agreement today among viticulturists in any discussion about vine density.

This is one of the most puzzling and intellectually stimulating topics in contemporary viticulture. Why are some vineyards in France planting up to 10,000 vines (or more) per hectare (4,000/acre) while in the Mid-Atlantic region the average vine density is about 900 vines per acre? What could account for this amount of variation? Is it a coincidence that many of the great wines of the world come from high-



High density vineyard on the North Fork of Long Island

density plantings, and what exactly is high density anyway? Is there a distinguishable threshold between low and high density. And what is the relationship between vine density and quality? The bottom line is, "can you taste the difference?" Myths and misinformation about vine density abound in the wine industry. There are few hard and fast rules and little scientific evidence regarding the impact of vine density on wine quality, so it is important to gather information from trusted sources and apply it in the context of the considered site. This author believes that so far as correct vine spacing and density is a function of soil capacity, the best

wines (and especially red wines) are produced from small to medium sized balanced vines grown on soils with low to moderate capacity. It should be quickly noted that very fine wines can be grown on larger vines but they rarely attain the quality level of the very finest wines. Your site will tell you what spacing and density is most suitable to create a balanced vine. Follow that lead.

Vine density will dictate how many vines there are in a unit area, but it mostly represents the three dimensional geometry of a vineyard. These are critical parameters for vine balance, productivity, and wine quality. Vine density is a tool that can be used to adjust the grape yield per vine and per acre. As density increases, the yield per vine usually decreases but the yield per acre increases. The total root surface area per unit vineyard area also increases, resulting in improved use of the available volume of soil. With a smaller amount of fruit to mature, each vine is better able to bring the crop to full maturity. Growers have observed that smaller vines tend to ripen their fruit faster, which provides an important advantage in a rainy harvest climate. In the Mid-Atlantic, high-density red wine vineyards typically harvest one to two weeks ahead of more widely spaced vineyards in the same area. The degree to which this phenomenon is influenced by density or other factors such as vine age is unclear, but the trend is hard to deny. In this context, density is a metaphor for all of the inputs responsible for the size of a balanced vine. Given the harvest weather conditions of the East, picking a week or two early may offer great advantages to wine quality. However, planting vines close together is not something you can just decide to do because you want certain results. It must be carefully planned based on site evaluation data that will suggest a density that is compatible with site capacity.

Problems with incorrect vine density usually reside with the space between vines, not between rows. Shoot crowding to achieve vine balance can have many negative effects on fruit quality, in particular creating shade that will delay ripening and increase diseases and bud fruitfulness problems. We have all seen the results of too many vines in too little space, it's a jungle. To some extent viticulture practices can make up for a vineyard's sub-optimal design features but it comes at additional expense and frustration.

Vine density is one of those lasting decisions that you do not want to regret, so study the options and try to get it right within reasonable limits. Fortunately, there are some measures that you can take to rectify what may have been an incorrect decision. If more linear feet of trellis are needed for each vine, a vertical shoot positioned system can be "bumped up" to a divided system, such as the one devised by Scott Henry. If vines are planted too far apart in the row, inter-planting at a later date is possible. If the row width is too wide or too narrow, rows can be inter-planted or removed. In one striking example of changing an old vineyard's density in Napa Valley - vines spaced 12' x 8' were turned 90° and inter-planted to a new 8 x 6 configuration that reduced the area per vine in half, which resulted in superior quality and yields. (Note that such post-planting measures should be avoided. This method avoided a complete replant but is certainly not an ideal solution since it resulted in vines of great age difference. In much of the East, where vine vigor is difficult to predict on virgin sites, the grower must conduct a careful site assessment to estimate vine size and vigor. In Bordeaux you may see vines on meter by meter spacing, but it cannot be assumed that this will work on more fertile soils, but it could lead instead to crowding and shading problems that will affect fruit quality as was the initial experience at Opus One Winery in California and Domaine Drouhin in Oregon. There is no formula for vine density, so you will have to take a reasoned approach guided by a careful soil evaluation and an estimate of site capacity.

Densities are increasing all over the world in vineyards that have been targeted for fine wine. In Santa Barbara County, 6 x 3 has become the standard spacing for high-quality red wines and vineyards are experimenting with even closer spacing. In Barolo the vine spacing may be as close as 50 cm (20") for Nebbiolo. Growers there clearly believe that that a qualitative relationship exists between yield per vine and wine quality, but this density can only be applied if the site capacity will accommodate the closer vine spacing. There are early signs that similar high density plantings may work in the Eastern U.S. as some growers push towards and past 2000 vines per acre but only less generous soils. The results of this reductionist wine formula are barely perceptible and yet practitioners (usually the most successful and wealthy ones who can afford the high development costs) are convinced that it will produce a better wine. Growers who do not reside in this rarified environment should consider the costs of developing and maintaining such a vine density are enormous, and the economic feasibility of the approach depends on the price of the wine that is produced. If the quality improves so markedly that a winery or customer is willing to pay more, then perhaps the investment can be justified. The return on investment of high-density vineyards requires careful analysis. Because of its additional cost requirements, high density vineyards are often associated with estate vineyards – the additional capital from wine sales help to offset higher development and maintenance costs.

If high-density vineyards exist, are there medium- and low-density vineyards as well? There are no exact boundaries but a low-density vineyard could be 12' x 8' (96 ft²/vine), a medium-density spacing 10' x 5' (50 ft²) to 8' x 5' (40 ft²), and high-density spacing 7' x 3' (21 ft²) or less. Native and traditional hybrid varieties are often grown at lower densities, higher quality hybrids do well at medium densities, and high quality *vinifera* seem to flourish at high densities, with premium red varieties in the tightest configuration. However, vine density is intertwined with many other site variables that can influence quality for better or worse. It would be risky to generalize and assume that a certain level of density or spacing represents the final word on wine quality. Density trials can help to tease out the effects of vine spacing on quality, but in the end it is up to each grower to draw his or her own conclusions about the economic, viticulture and wine quality ramifications of high- versus low-density planting.

One notable dissenter from the school of high-density viticulture and its relationship to wine quality is Stephen Mudd on Long Island. He has planted vineyards with from 700 to 2500 vines per acre and failed to observe an improved return on quality and investment in the high-density vineyards. It would be worthwhile to consult Mr. Mudd prior to making a density/spacing decision. During your research you will discover many views on this issue, so try to obtain data from different sources before deciding what to do on your site.

The optimal solution for your vineyard lies somewhere in this tangle of numbers. It is indeed a complex, multi-dimensional problem. Regardless of the density and spacing you opt for, high-quality viticulture must be practiced to make it work. Density is just one element among many pre-plant decisions that will have a significant impact on quality. In matching a virgin site to vine density, even the most experienced grower cannot do more than to conduct a full site analysis and then make an educated guess. If it doesn't work, perhaps the next generation to farm the vineyard will get it right.

Row and vine spacing

Between-row spacing must be determined by the height of the canopy and is driven by the need to maximize production per acre. The more rows you can squeeze onto an acre of land, the more grapes you will produce. Allowing enough space between rows is crucial for light

penetration, however, and the ratio of row width to canopy height (not total height) should be at least 0.8 (Kees van Leeuwen). In the U.S. a 1:1 width-to-height ratio is common and usually the row width will be slightly larger than the vine spacing. For a 6-foot-high canopy, the distance between rows should be at least 6 feet to allow the proper penetration of sunlight to the lower parts of the canopy and fruit zone in the early and later periods of the day. In Bordeaux a one-meter row width allows for an 80 cm (32") high canopy. Now that's really low!

Many numbers and ratios have been calculated for optimal canopy, leaf and fruit measurements, but in the East a shoot length of 15-20 nodes or 36-42 inches is desirable to fully ripen the fruit. Row widths in *vinifera* vineyards can vary from a tight 7 feet to a more typical 8 to 10 feet. Row width must also accommodate your equipment, with at least 6 inches to either side of tractor tires or farm implements on a flat surface and even more on hillsides. If a divided horizontal trellis system such as Geneva Double Curtain or Lyre is used, then an even wider spacing will be necessary. Anything below 6' will probably require special and very expensive narrow equipment such as over-the-row tractors. Decide on the optimal row width and vine spacing based on viticultural requirements, and then find the right equipment to fit those dimensions.

In-row vine spacing in the East for *vinifera* varieties will vary from 3 to 6 feet, with the wider 6-foot spacing being more suitable for fertile soils, white or high quality hybrid varieties, or older vineyards. Native and hybrid varieties are usually given more space to spread out; up to 8 feet is not uncommon. The average for most vineyards is probably 5 to 6 feet. Most growers would like 2-5 shoots per foot of trellis. This amount of space should be able to comfortably accommodate most varieties on typical soils in the Eastern climate. Close in row spacing will to varying degree raise development and maintenance costs of the vineyard.

Training and trellises

Vine training and trellis systems are inseparable partners and while neither are necessarily required in the first year of vineyard development, they are in the very center of the design process. Vine spacing can be influenced by trellis choice, especially if a horizontally divided system like Lyre is used. An important consideration is the training method that you will use. If you are cane pruning, then the vines should be spaced no more than 5 feet apart, and preferably 3 to 4 feet. Cane pruning can reduce disease by limiting the amount of old wood on a vine. Long cordons are vulnerable to winter injury in cold regions and are harder to renew. Training decisions should be decided now but will not be implemented until the second or third year of development. There are many reasons to choose cane or cordon including bud fruitfulness, yield, and perhaps most importantly with many varieties, tradition.

Vine spacing will influence your training and trellis system choices. For high-density vineyards, the vertical shoot positioned system (VSP) is the only practical choice. For more vigorous sites, divided trellis systems such as the Scott Henry or the Smart-Dyson may be appropriate. Keep in mind that horizontally divided systems (e.g., Lyre or Geneva Double Curtain) need more space between the row than single vertical systems in order to accommodate more foliage and equipment access. These are all important vineyard design considerations. In-row spacing will also affect equipment use and efficiency. A grape hoe has a difficult time cleaning out weeds if the vines are spaced closer than four feet apart.

Deciding on the correct trellis and training system to use is a good example of the cascading effect of site capacity on other critical components of vineyard design. Once the site capacity has been evaluated and the parameters to achieve a balanced vine determined, then the

proper vine density and spacing can be assigned, and the most appropriate trellis system for the conditions of your vineyard and vines can be chosen. In a terroir with higher vigor, a divided system may achieve the best vine balance and fruit quality. If site capacity is in the low to medium range, a single canopy system such as VSP is usually the preferred choice. A high cane or cordon with a single panel will require more between-row space than VSP because of its spreading umbrella configuration, which takes up more space between vine rows. Horizontally divided systems certainly require a greater between-row distance, but even a vertically divided system will need some extra space.

As with most aspects of vineyard development, it's necessary to envisage how the vineyard will look several years hence and make plans now to establish a balanced vineyard system. The exact training methods do not need to be determined yet (we will consider this problem in Chapter 16), but it can't hurt to start thinking, for example, about the relative merits of head versus cane versus cordon-trained vines.



Chardonnay on classic Vertical Shoot Position trellis, the most widely used wine growing trellis in the US.



Merlot on vertically divided Scott Henry trellis: note upward and downward growing canopy panels and two fruit zones – wider spacing needed.



Norton on horizontally divided Geneva Double Curtain: two side by side high wire trained cascading canopies with clear center aisle – widest spacing necessary.

Chapter 13

Vineyard Infrastructure

Infrastructure constitutes an important but under-appreciated aspect of a successful and efficient vineyard operation. It includes all the non-viticultural support systems that allow a vineyard to function efficiently, safely and economically. These components are often not considered until the need arises, but careful planning of critical resources – water, utilities, roads, structures, safety measures and so on – the smoother the operation of the vineyard will be. A useful exercise is to imagine what it will be like to work under the worst conditions, such as rain during harvest, and then design an infrastructure that will allow you to get the job done with the least effort and risk.

Preparing an infrastructure map that overlays the vineyard map will help to bring the entire vineyard system into clear focus, with its soils, varieties, clones, rootstocks, trellis systems, rows and blocks, wells and irrigation system, buildings, roads, gates and fences, and other vineyard components. Together they will serve as the blueprint for the vineyard development project.

Critical Needs (Water, Electricity, Roads and Work Areas)

Water

Water is needed for many purposes: irrigation, to feed different types of sprayers, and for cleaning, general health and safety. A reliable source that will meet all needs without fail even (and especially) in a drought year is essential to a smooth vineyard operation. Most vineyards are too remote to tap into a community water system, so a well, pond, stream or spring source will need to be developed. Whatever the source of water it must be clean, with a pH and salinity and impurity levels that are within acceptable ranges for all the uses planned for it, including drinking water.

Developing a water source can be as nerve-racking and challenging as finding a good vineyard site. How is water found? Geologists and hydrologists can help to identify potential sources. There is the witcher (also called a ‘dowser’), an individual who uses divining rods to find things that are hidden. Local growers or well drillers may be able to recommend a good water witcher who will help to find the right spot to drill. The witcher’s findings can be crosschecked with those of a hydrologist. Looking at the existing water sources around the property could also be helpful. Once you find a place to drill, call in a drilling company with solid references.

Developing a water source can also be expensive. Drilling a well involves both art and science and is something of a hit-or-miss operation. The cost of drilling is \$5 to \$10 per foot plus an additional \$10 to \$15 per foot for 6” casing to bedrock. A dry well attempt can be a very costly error. Ponds are helpful when large amounts of water are needed in a short period of time (e.g., for frost protection), but a lined irrigation pond may be even more expensive to put in than a well. Assess the full portfolio of water needs and then develop a source with enough output to meet these needs.

Electricity

Vineyards are often located in remote areas and gaining access to electricity may be difficult. While electrical power is not essential on every farm, it is certainly useful to have for tool and equipment operation. If electrical devices such as well or winery pumps require 3-phase

AC power it will have to be brought in or else an electrical power inverter must be used. The electric company can help to decide what application would be most appropriate and economical for the equipment. It is extremely expensive to develop 3-phase power, so if only a modest amount of electricity is required in a remote location, modern gas or propane-powered generators offer a quiet and efficient alternative.

Roads and work areas

Roadways and work areas are often taken for granted and yet they are of critical importance, especially at harvest time. They should be designed to make work possible even under sloppy conditions. Access to all areas of the vineyard will be necessary. Roads should be wide enough to accommodate the largest equipment that you anticipate using, for example a tractor-trailer semi. Most vineyards will have at least a few dirt roads, and dust and potholes can become a nuisance. Gravel roads are preferable and should be constructed properly using a base of 2" minus rock under a layer of ¾" minus to provide a stable and durable driving surface. Attaching a blade to the tractor can help to maintain the road. Turn-around areas for trucks (including the tractor-trailers for grape deliveries) should be developed in appropriate sites around the vineyard.

Work areas will be needed at harvest for loading and unloading trucks with grape bins. Wherever possible these areas should be level and flat with a gravel surface (or a very durable grass) to facilitate operations in wet conditions. Remember that it is extremely difficult to load full bins of grapes onto a truck if the tractor tires are slipping.

Buildings such as barns and offices are not essential, but using a pickup truck as an office is not a good solution. Record-keeping and information retrieval are vital to running a vineyard these days, so it is important to have access to the internet, filing systems and means of communication, not to mention a comfortable place to rest and eat lunch. A small lab to run grape samples during harvest can be helpful. It is also necessary to have a meeting place where classes in worker protection standards can be conducted and EPA worker protection standards materials posted (emergency phone numbers, etc.).

A big part of farming is using and maintaining equipment. Equipment, supplies and tools are the lifeblood of a farm and every piece, from tractors down to shovels and wrenches, deserves a storage place out of the rain and sun. A proper facility, such as a pole barn with a concrete floor and electricity, is essential to maintain the quality and longevity of your equipment. An open workspace with proper lighting and safety features will facilitate equipment repairs. A dry, well-lit and organized storage area will help to extend the life of supplies and make them easier to store and find.

In humid regions spraying plays an important role in grape growing. Significant attention should be devoted to all aspects of spraying, from record keeping to weather forecasting and clean-up. A secure and dry chemical storage building is needed to store pesticides, and handling and safety equipment. A nurse tank that can be filled while the sprayer is in the field will shorten the refill turnaround time dramatically. Providing an area where sprayers and equipment can be cleaned with the least possible environmental impact would be an excellent investment in terms of health and safety; this should include a spray pad that drains to a storage tank. In some areas like Long Island there are very strict local regulations which require run-off mitigation.

Three Key Infrastructure Systems: Deer Fence, Irrigation and Drain Tile

Deer fence



10' exclusion fence protecting valuable Chardonnay vines

Consult with local conservation authorities and neighbors to determine whether deer populations are high in the vineyard area. The novice grower may not realize the damage that deer and other animals can inflict on vines of all ages. Deer are everywhere now and they are very efficient in stripping new vines of their tender young shoots and mature vines of fruit. It's a shock to see all the leave gone from what was the day before a lush new vineyard. Fencing is expensive at \$7 or more per foot, but deer (together with birds) will be your greatest vertebrate challenges and protective measures should be part of the vineyard budget. There are various options

to exclude deer, but it is worth investing in a durable and effective exclusion fence, 8' to 10' high and installed by a reputable fencing company that goes around the perimeter of your vineyards, particularly if there are wooded areas nearby. Ideally the fence will be partially buried to keep animals from burrowing underneath and the mesh openings should narrow towards the bottom to exclude rabbits, raccoons and other smaller critters.

Irrigation

As a rule too much water is a much greater concern than too little in Eastern wine growing. Just as having excess water can cause grape quality problems, drought conditions can impair vine functions and also cause a loss of quality. In some vineyard applications, especially high value wines or extremely droughty soils, having irrigation makes sense. It can also be helpful in establishing new, young vines, especially in dry years.

It is obvious that vines need water, but the question is when and how much, and should one go for irrigation or for dry farming (farming without supplemental water)? New vines have limited root systems, so water is needed to encourage vine growth. With irrigation available the vines may produce that all-important first crop sooner. Whether to dry farm or irrigate is a tricky decision, one that is made all the more difficult by the expense of putting in a drip system, especially if a water source has to be developed. The cost of such a system, considered on top of all the other development outlays, often results in it being kicked out of the budget. But since we are allowed the option of using irrigation (unlike many high-quality regions in Europe), it is a tool that should not be ignored.

Irrigation is complicated and expensive to install and requires constant maintenance. In addition, there is very little information regarding the monitoring of soil moisture, and the proper use and timing of irrigation for vineyards in the East. So why should a grower even bother? Perhaps the best way to look at the decision, as is so often the case in wine growing, is what may be lost if something, in this case adequate water, is missing from the long list of necessities to produce fine wines. If drought conditions afflict vines after veraison, key physiological

processes associated with ripening will be impaired and it is likely a lesser quality wine will be made. It could mean the difference between a reserve wine being declassified to a regular label, or a wine being sold as bulk product because it could not qualify as a standard wine. If the losses are then measured in retail value, it would not take much declassified wine at all to pay for any irrigation system. Irrigation is one of the many insurance policies that grape growers carry against the whims of Mother Nature. Others include frost prevention devices, deer fences, spray equipment, etc.

Most vineyards in the East (including irrigated vineyards) are dry farmed and it must be said that this works well in most years. It is an irony of Eastern viticulture that so much effort is directed at removing moisture from the soil (via soil drainage, artificial drain systems, cover crops, etc.) whereas at other times it is necessary to add water. During dry years even mature vines, especially those on light soils, may need supplemental water to push them through to harvest. It should be noted that there are significant gaps in our understanding of water issues, including vineyard irrigation, in wet climate regions and few, if any cut and dried recommendations regarding scheduling or best practices. Wine growers on Long Island may have the most experience to share on the use of supplemental water for vines growing on sandy soils. Furthermore, no one can predict how climate change will affect the need for irrigation in vineyards in the East in the future.

Electrical power and an adequate water source must be available if you are going to install irrigation. A good drip irrigation system can cost upwards of \$4,000 per acre to develop. It is very important to design and install the system correctly, especially the underground portion, because once it is buried changes and repairs become very difficult. Most of the underground system through to the risers should be professionally installed. Unless you are a hydraulic engineer, decisions regarding flow rates, slope, block size, valve locations, etc. should be left to a professional. Water quality needs to be assessed and proper filters installed to remove impurities that can clog the emitters and small orifices.

The amount of water needed will be determined by the size and design of the irrigation system. A water engineer from the irrigation company can provide a map of the irrigation system design. The characteristics of the blocks, slopes and other local features will influence the design of the system. In the most sophisticated applications, double drip lines are used – one to supply each vine in the row and a second to supplement the main line for replants or weak vines that need more water.



Drip irrigation can help establish new vineyards and improve quality in older ones

The science of irrigation is still in its infancy in the East, unlike more arid regions such as California and Australia. However, with the droughts seen in recent years, the potential benefits of drip irrigation are becoming more and more obvious.

Irrigation has always been encouraged for the development of new vines, especially if there is the risk of a dry growing season. Young vines with shallow roots are very susceptible to water stress. It is possible to use temporary water delivery systems such as sprayer tank and movable drip but they

are not as efficient as an in-place irrigation system. Drip irrigation also offers the option of fertigation, in which nutrients are metered to vines at a specific rate over a given period of time.

Irrigation systems tend to require a lot of maintenance. Problems with electrical systems, valves, clogged or missing emitters, leaks, and animals chewing on hoses above and below ground. Be prepared to spend a lot of time with the irrigation system.

If a well is being drilled or a stream is being tapped for water, the user should investigate local water usage ordinances and water rights carefully. While not as divisive a topic as it is in the West, water is a limited resource so be sure that you are entitled to draw on the source necessary for the irrigation system. The USDA Natural Resources Conservation Service (NRCS) has information about local water rights, as do the county government and state water resources department.

Drain tile

Drain tile and irrigation can be used as complementary tools to fine-tune the performance of a vineyard. In some years you may need one or the other, and in rare years both. But their main purpose is to provide the grower with flexibility and options in manipulating vine growth.

Excess soil moisture, especially at the wrong time in the growing season, can be detrimental to grape quality. The level of soil moisture that is desirable depends somewhat on the style and type of wine you are trying to grow. In the case of high-quality hybrids and *vinifera*, moderate water stress after fruit set and before veraison can help to moderate shoot growth and improve berry ripening. These viticultural characteristics can also enhance potential cold hardiness. It is helpful to have a good understanding of the amounts and distribution of summer and autumn rainfall in your vineyard's mesoclimate. Soil texture and slope will have the greatest impact on the drainage ability of soils. The goal is to remove excess water quickly from the surface and the effective root zone of the vines. A soil will drain to field capacity by gravity, but the roots will still have access to water. Draining the soil still further, towards the permanent wilting point, will create the mild stress that is wanted after fruit set and near veraison.

Plant-available water (PAW) is the measure of the soil moisture available for root uptake. The soil is almost always well charged with water in the spring when rain is plentiful. During the summer PAW fluctuates with rain events and water infiltration. This is difficult to control, but using drainage tools and irrigation it is possible to influence the amount of water in the effective root zone of the vines. A soil evaluation will be the most important factor in the decision whether or not to artificially assist soil drainage. If the soil is primarily heavy clay with slow drainage, it could benefit from tiling. At critical times in the growing season, the additional drainage may provide the mild stress necessary to moderate berry size and shoot growth. A good example of the widespread use of tile drainage is in the clay soils of the Niagara Peninsula. Here, virtually all of the new *vinifera* vineyards are installed with tile in every row middle.

Drainage tile has been shown to be very cost effective as it allows for better root growth, quicker vineyard access to perform critical tasks such as pesticide applications during periods of high pest pressure, access for harvesting in the fall, and a method of reducing soil compaction and other structural problems. In Ontario laying tile down the center of each travel row (8 feet for laterals) has resulted in higher quality fruit and higher yields over many years. A moderate increase in production (½ ton per acre) can easily pay for the costs of installing the tile.

Excess water can be removed from the vineyard using surface and subsurface drainage. Shallow surface channels, drop inlets and storm drains are able to divert and remove large quantities of overflow water. They all rely on the topography and proper drainage routes to move water off the property.

There are different ways of installing drain tile. A typical subsurface tile drain will consist of 3-4" perforated flexible pipe wrapped in landscape cloth and laid in a 2-3' trench on a bed of gravel, which is then covered with gravel and buried, all with the correct pitch and drainage outlet. In Ontario, a large machine digs a channel and tile is laid and covered all in one process. The distance between tiles is key to the proper performance of the system and should be determined by a hydraulic engineer. The design, and usually the installation, ought to be carried out by professionals to obtain the best results. The local NRCS office will have soil conservation personnel who can assist with the evaluation and design of a drainage project. There are also private companies that provide this service. Drain tile should be installed after the vineyard is designed, but when the open field is still available. It should be clear to the designer and installer that the area being drained is a vineyard, not a field of row or cereal crops. All lateral tiles should run in the rows and end at a main that is large enough to carry excess water to the proper outlet or ditch. Do not install laterals across rows, especially if you are possibly going to subsoil periodically.



4" drain tile ditch with a layer of river rock

Tile Drainage in Vineyards in Ontario, Canada

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Introduction

Tile drainage in vineyards has a long history in Ontario. A 1910 drainage plan shows 3-inch clay tiles at 70-foot spacing in a small vineyard near Vineland. Today tiling vineyards is not considered to be an option but a necessity in order to consistently grow good quality grapes. It is estimated that if all the tiles in Ontario vineyards were connected from end to end, they would stretch for more than 500 miles from Fairbanks, Alaska to Key Largo, Florida!

Benefits

There are 7 main benefits to be had from tiling vineyards:

1. Quicker vine establishment
2. Better quality and more uniform yields
3. Higher spring soil temperatures because evaporating water *steals* heat from the soil
4. Increased soil aeration and biological activity
5. Increased bearing strength to reduce slippage on field equipment
6. Roots penetrate deeper, so plants can withstand droughts better
7. More timely access to the vineyard for field work after wet weather

Type of Water

There are three types of water around grape vine roots. *Gravitational* water fills the voids in the soil. Plants can't use it so it drains by gravity to tile drains. *Hygroscopic* water is absorbed on the soil particles. Plants can't use this either, but because it is so tightly attached it won't drain by gravity. *Capillary* water is a film on the soil that the plants can use. It also cannot drain away by gravity, because capillary forces hold it against gravity. So tiles drain away only the excess gravitational water. In Ontario tiles are usually placed with about 28 to 30 inches of cover in heavier clay soils, and with slightly less (24 to 26 inches) in lighter soils.

Theory vs. Practice

Theory says that tiling every 18 feet (every other row at 9 foot spacing) is enough, because water only has to travel 9 feet horizontally to find a tile. However, the practice is to tile every 9 feet because of surface crusting and wheel traffic compaction.

Theory also says that tiles larger than 2 inches in diameter are not needed since this size is sufficient to carry all the water. However, the practice is to use 3- or 4-inch tiles since plugging can be a problem with small tiles, especially those on very shallow grades.

Theory says to place tiles across the slope so that surface water always has to cross over a tile line. However, in many grape areas of Ontario rows are run north-south because of the sun location and topography. The practice is to install tiles in line with the grape rows because this is more practical for repairs and is less likely to result in grape anchors hitting tile lines.

Theory says to just tile the wet areas and not the drier areas so you can save money. However, the practice is to tile all areas equally and at the same time since this evens out vineyard growth.

Drain tile continued >

Fraser: drain tile continued...

How do I know if I need tiles?

There are several things to check in a vineyard:

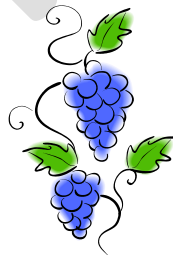
1. Does water pond between rows after a rain?
2. Is there side-hill seepage in adjacent ditches?
3. Does machinery leave ruts?
4. Are crops variable?
5. Is there any water-loving vegetation present, such as horsetails or willows?
6. Is the land flat with heavier soils?
7. Do post-holes fill with water?
8. If a vertical trench is dug 36 inches deep, is there evidence of soil crusting near the surface, hard pan levels down about 12 to 18 inches, or very shallow vine roots?

Surface Water Management is also Needed

Tile drains can work miracles in many vineyards, but they cannot substitute for good surface water drainage management. Tiles alone will not remove all water, even with many catch-basins or other surface inlets. Many Ontario grape growers level their land prior to planting in order to improve surface water drainage and promote good air drainage.

Conclusion

Tile drains are a forward-thinking, long-term investment in vineyards that are a given, not an option, for Ontario grape growers.



Chapter 14

Site Preparation

There is no one way to prepare a site for planting although there are some generally prescribed guidelines. You will want to have a clear plan and to be as methodical and careful in your site preparation as you would be for the seedbed of a garden.

Fields that are open and clear are generally easy to convert into vineyards, while those with variable contours are more challenging. The rough boundaries of the vineyard and the specific blocks of vines should be marked for the various steps that precede planting, from putting in deer fence, drainage and irrigation to the soil prep work and lay out. The surface of the field should be smooth and uniform. The subsurface should be free of chemical and physical impediments.

This is the one moment in the life of a vineyard when it will be a clear field. Among the first decisions is when to install the trellis and vines, irrigation system, surface drainage and drain tile. This will directly affect when and how the field can be prepared. Once posts, wires and vines are in the ground, the working space will be severely restricted so now is the time to control weeds, cultivate and amend the soil, and install underground irrigation and drain tile if necessary. These site preparation steps should be carried out in the summer and fall before planting.

Specialized equipment

The first stages often require specialized equipment in the form of tractors and soil conditioning implements such as rippers, plows, discs, and harrows, which demand more horsepower than the typical vineyard tractor can muster. This is not necessarily equipment that any new grape grower will want to purchase due to its price and limited use. A source of suitable equipment and operators needs to be found before development can move forward. Usually row crop farmers will own some larger farm equipment. An excavation company will have tracked vehicles and ripping implements. If lime needs to be applied, there are specialized lime spreaders, which are very large machines with balloon tires that require a lot of space to operate. Lime should be applied according to the type and amount specified in the soil evaluation.

Analysis of the soil for pests and pathogens

There is usually an economic imperative to get a field into production as quickly as possible, but the long-term benefits of reducing harmful soil pathogens, chemicals and other potential problems could provide greater rewards – both financially and qualitatively – over the life of the vineyard. If the field was previously planted with vineyards or orchards it should be carefully analyzed for soil pests. It will be a great advantage if the field can be left fallow for 1 or 3 years to recover from an extended period in monoculture. Soil-borne pathogenic fungi and bacteria can also build up over time in vineyards and orchards, and a new vineyard will benefit greatly if you manage to reduce these populations during a fallow period. Soil testing can guide this decision. Of special concern are nematode populations, which can be high in sites previously planted with vineyards and orchards, especially older ones. If a soil renovation program is adopted (see *Wine Production Guide for Eastern North America*), this will require that the field be left fallow for the period of treatment.

Depending on the type of crop previously grown, such as corn, soybean or Christmas trees, there may be a concern about residual herbicides in the field, such as Atrazine or Poast, in

which case a program of charcoal neutralization may be needed. Checking with the farmer who grew the previous crop could bring to light possible problems. Be aware that pesticides and other materials can also drift into vineyards from neighboring fields.

Clearing the land

Land clearing is an arduous and often expensive process, especially if deforesting is necessary. The job of cutting and removing timber, and pulling up and burning stumps is better left to experts. Because the work can be dangerous, it is recommended that a professional who understands the work and has the required permits be engaged to deforest. Depending on the type and value of timber involved, some or all of the cost of its removal may be recovered.

Don't let the crew leave until the results have been inspected and approved! Otherwise there may be a large pile of smoldering stumps left to remove. As much as trees can be a problem for wine growing, a few large trees can be left in strategic places for their aesthetic value or the shade they provide (the vineyard crew will appreciate this later). A forest cleared for vineyard should be left fallow for 1 to 3 years before planting.

Keep in mind that neighbors may be unhappy with trees being felled or any other changes to the landscape. They will be watching and wondering and almost always assuming the worst, especially if the vineyard is the first in the area. See the chapter on site selection for more about neighborhood relations.

While the field is open is the best time to remove large obstacles, which may be described as anything bigger than your fist, from rocks to refrigerators, old fence posts and wire, and whatever other debris might be in the field.

Shaping the land

There is much debate about the relative value of land grading, contouring, or terracing of vineyard sites. In general, low spots such as swales and gullies should not be planted. Small depressions can be repaired to encourage drainage and discourage the pooling of water and cold air, which may result in cold injury to vines, in Ontario, this practice is widely used to mitigate frost and freeze situations. However, the wholesale scraping, shaping or back-filling of large areas should be avoided, because even shallow scraping can have a dramatic effect on soil physical and chemical properties. These effects, often in the form of weak or nutrient deficient vines, do not appear until after the vineyard is planted. If you are considering such measures or they have been recommended to you by a consultant, then you should ask yourself why it is necessary and how it will help to improve the vineyard.

Many of the most spectacular and memorable vineyards we see are on terraced hillsides such as the Mosel or Hermitage. Most were developed long ago. Terraces demand great skill to form and maintain (requiring a tractor). They are generally discouraged for safety reasons (particularly on steep slopes over 30%) and because they represent a very inefficient use of the surface area. Terraced vineyards make weed control and all vineyard operations more difficult (hedging, mowing, spraying, etc.). Vineyard slopes with rows across the face will tend to natural terracing with the use of cultivating equipment, which makes equipment operation easier. On very steep terraces a tracked vehicle is the most practical for safe operations.

Soil amendments

Now is the time to amend the soil if testing indicates nutrient toxicity, deficiencies or other problems. If more organic matter is needed, the fallow period is a good time to plant the

field with green manure-type cover crops (such as legumes) that can help to build up the soil organic matter to desirable levels. A stubble disc can be used to chop and turn under plant residues.

This is the best time to adjust the soil pH. Lime/gypsum spreaders typically are huge machines with large balloon tires designed to reduce soil compaction and “float” over wet fields. They cannot, however, squeeze down an 8’ row. If added, the lime or gypsum should be incorporated as deeply as possible at the recommended rate.

This is also the time to add amendments such as compost and fertilizers where necessary. Compost can improve both the nutrient content and soil structure of a field. A soil or viticulture consultant, along with a fertilizer vendor, can help to determine the products and rates necessary to improve a soil’s health and condition. Apply them before or after plowing and disking so they can be incorporated as deeply as possible into the soil. While you will be able to make minor soil adjustments after planting, this is the ideal time to make major changes. Remember that it is best to be conservative and not overdo any amendments – more is not necessarily better. Also remember that the main goal is to create and maintain a viticultural, not an agronomic soil.

Weed control

Weed control is of paramount importance and should begin during this site preparation phase. Weeds may be the most significant problem in new vineyards. They compete aggressively for water, nutrients and light, and can temporarily or permanently hamper the growth and health of young vines. An open field is the best opportunity to control weed populations before planting.

The type of vegetation on the site should be assessed and an appropriate weed control program designed. In timbered areas the weeds might consist of tough woody perennials such as poison ivy and blackberries, which are very hard to remove. But most fields will contain a standard variety of grasses and/or broadleaf weeds. These can be eliminated with post-emergence herbicides such as glyphosate products, applied with a boom applicator from a herbicide-dedicated spray tank. Herbicides can be very effective during the site preparation phase, even if there is no intention to use them late in the vineyard floor management program.

As a rule, the use of herbicides should be minimized as much as possible, and at all times chemicals should be delivered accurately and at the proper rate on targeted plants. The better the weed control is upfront, the less of a problem it will be later on. It is extremely difficult to implement chemical and/or mechanical weed control around tender new vines in the first growing season. The foliage grows low to the ground and is very exposed to herbicide drift or mechanical damage.

Some growers will elect not to use herbicides. In this case a field can be cultivated to remove weeds, but weeds are likely to reappear after vines are planted. Multiple passes with tillage equipment may be necessary before weeds are adequately controlled. If a field is cultivated for weed control, it will need to be planted with a winter cover to hold the soil in place during the rainy season.

Soil conditioning: Ripping

One grower interviewed for this manual stated emphatically that soil conditioning can make or break a vineyard for its entire life span. Therefore great attention needs to be paid to the steps involved in preparing the soil.

The texture of the soil must be well understood – i.e., the proportions of clay, sand, silt, loam and rock – in the soil. This affects the moisture and workability of the soil and a correct evaluation will help to avoid soil compaction. There are tools that accurately measure soil moisture, but farmers and soil scientists usually rely on their sense of touch and sight to determine relative moisture and whether a soil can be worked in or on.

There are many ways to cultivate a field prior to planting. The standard method is to deep rip to 2-3 feet in two or three directions to break up any plow or hard pan that might impede root development. This requires a large tractor or Caterpillar (D-6 or larger) to pull a long shank. It is crucial to have proper soil conditions during this procedure. If the soil is too wet the blade will simply smear and glaze a narrow channel through the soil, causing further root impediment. A dry soil may be too hard to drag a blade through it. An experienced operator will be familiar with these conditions and will know that the soil must be relatively dry to the depth of the rip. Some vineyard developers now employ a winged-plow directly on the vine row that lifts and crumbles the soil at a uniform depth, which will allow the even distribution of roots for all vines. Practitioners claim that this practice builds uniformity in vine size, especially if the proper



rootstock is used. The winged plow is a specialized piece of equipment and may have to be custom-made. Alfred Cass, a soil scientist in California, has written extensively on the use of the winged plow.

Vine rows should already be planned (usually by GPS) before ripping begins. Soil compaction should be analyzed and avoided. You should monitor and try to minimize soil compaction during all of the preparation and installation processes. Only if the soil evaluation reveals a uniformly distributed field of good texture and structure, then ripping may not be necessary.

Winged plow for on vine row ripping helps soil and vine uniformity

Installing drainage systems

This is a good time to install surface water drainage systems based on the plans drawn up by the county USDA soil and water conservation office or environmental engineers. It may be possible to catch and retain run-off to provide irrigation water. Even if the field is relatively flat it is worth having it mapped by GPS for elevations, and its hydrological features evaluated for surface and subsurface drainage needs. The more water that can be removed quickly from the surface after a heavy rainfall, the less water will penetrate into the soil and root zone. Obvious wet spots in need of drainage should have been determined in the soil and site evaluation process, as these will have an impact on your development budget.

Drain tile can also be installed at this time. Try to find a tile installer who has experience with agricultural projects. Drain tile is employed extensively in heavy soils such as clay to assist with water removal and aeration of the soil. It is widely used in the Niagara Peninsula region with good effects on vine performance and quality. Aerial photography is an excellent way to monitor the effects of drain tile in a field. There are many important decisions to be made when installing drain tile, such as depth, pipe size, the distance between tiles, drainage direction, etc.

All of these should be determined by a professional. It is necessary to have the final layout of the field planned beforehand to ensure that the drain tile is installed properly in the row middles. The Natural Resources and Conservation Service can assist with all drainage projects and refer you to professional installers.

Pests

If nematodes have been identified as a potential problem, now is the time to treat the field. There are effective chemical nematicides registered for use in new vineyards, but these are not widely utilized or preferred. Soil fumigants can have a devastating effect on the living soil, killing the good as well as the bad. A less invasive alternative is soil reconditioning with grasses such as Sudex or canola, whose roots exude a mild toxin that suppresses nematode populations. There is a very specific protocol that must be followed for this process to be effective and it should be done the year before the spring of planting (see the information resources list).

Cultivation continued: Plowing and disking

Following the addition of soil amendments and ripping, the field can be moldboard plowed. As with ripping, the soil conditions must be right, which means neither too dry nor too wet. After plowing, the goal is to break up large clumps into smaller and smaller sizes. The next step is to disc the field in two directions. Ripping, plowing and disking can be done in the summer/fall prior to planting. A spring tooth harrow will prepare a field for seed.

In the fall, a winter cover should be planted. The type of cover crop used depends on its purpose – whether to simply hold the soil in place or to provide “green manure” to the field. Annual grasses like rye and oats will establish quickly and hold the soil in place through winter rains. Legumes can provide nutrients to the soil.

In the spring the cover can be plowed under, followed by cultivation with a spring tooth harrow and then a cultipacker or drag tool to create a smooth surface with dirt clods less than one inch in size. While rotovators create an aesthetically pleasing, flat, clean field, their pulverizing action destroys the soil structure and therefore is not recommended for use in vineyards at any time. Excessive cultivation can increase erosion, and decrease organic matter and permeability. After cultivation the field should be free of dirt and plant clumps, and flat enough that a line can be laid on the surface without interference from debris.

It's not a common practice but some growers plant vines directly through the existing sod in the field. In these cases it is recommended that herbicide strips be established along the vine row before planting to moderate the amount of competition from the cover crop. Irrigation should be available, especially in case of drought.

Laying out and marking the field

During the site evaluation process a vineyard design map was generated that lays out blocks with rows, varieties, clones and rootstocks according to the soil and climate. Now it is time to draw that design on the ground.

If a laser planter is being used, there is little need for a detailed layout of the blocks on the field since the planter itself does this by GPS as it is driven. But if a vineyard is being planted by hand or by other planting device, it is necessary to have clear guidelines just to be certain that the desired configuration and straight rows are achieved.

There are many ways to lay out a vineyard. If multiple blocks of uneven dimension on variable terrain are involved, this can be complicated and a professional surveyor should be

hired. If the fields are relatively flat and the blocks are not too irregular in size and shape, the layout can be done with a surveyor's transit, a few tools (marking flags, etc.), and the trained eye of a skilled operator. With GPS it is possible to lay out a field exactly as it was designed on paper. In all cases, a block begins with a reference corner and side from which a first row is made - usually a road, fence, tree line or any well-defined feature that can serve as a guide. A transit will help to shoot straight lines across a field with correct corners.

Fence wire, applied and painted at proper intervals, can be used as a marking line. The line can be wound on a garden hose reel and cut with a nicopress (wire splicing sleeve). Once the base line is set, the rows can be shot at 90s from this line with flags to mark their position. Popsicle sticks or plastic knives make perfectly good (and inexpensive) vine markers.

Final checklist

Before planting, the following should be made ready: trellis materials and installation equipment; plans for above-ground irrigation installation, testing and scheduling (if not a drip system, then some other contingency watering plan in case of drought); fertilizer with rate and distribution plans; mulching materials and a method for dispensing in the field; a strategy for training new vines (unless you have decided not to train); rabbit and deer protection in place; disease and insect pest control plan in place with materials, rates and sprayers ready; weed control methods (chemical and/or mechanical); the necessary labor for planting or a machine/laser planter, and of course, the proper labor and supervision to insure that the work is done properly.



Properly prepared field, marking with flags and ready to plant

Chapter 15 Planting

From the nursery to your vineyard

Arrangements should be made with the nursery to receive the vines just a few days up to a week before planting. This is where a good relationship with the nurseryman will pay dividends. Nurseries usually want to get materials out of their warehouse to their customers as quickly as possible, but they have proper storage facilities and conditions, whereas farms probably do not. As soon as the vines leave the nursery they belong to the grower, so it's better if the nursery is responsible for them for as long as possible.

If the vines are coming from California or some other distant nursery, the timing and conditions of shipping are critical. Many nurseries will want to air-freight the live plants but this can be very expensive. In March/April the weather can be variable, so monitor the forecast and temperatures to find a cool window to ship in. Dormant vines do not want to get stuck in a truck or warehouse without climate/humidity control when an early heat wave hits. Everything must be done to ensure that dormant vines arrive with very tight buds.

Request instructions from the nursery about how the plants should be stored, prepared and planted, and follow these instructions closely. If there is a problem after the vines are planted, you want to be able to say that you followed their instructions to the letter. It would be prudent to document what preparation and planting procedures you followed in notes and photographs.

The vines arrive...

Dormant plants come from the nursery as own-rooted or bench-grafted, and will be either bare rooted or in small pots. The buds should be very tight with no sign of breaking. If they are pushing, there will be added urgency to get the vines in the ground. If the vines are bare-root they need special attention to make sure the roots do not dry out.

Upon arrival the vines should immediately be counted and checked against the shipping invoice for correct size (all #1s – make sure you know the nursery standard for a #1 vine),



Inspection and testing of new dormant benchgrafted vines is essential before planting

variety, clone and rootstock. Then they should be sorted for efficient planting and stored in a cool, dark, moist area (inside a barn or under dense tree cover). If bare rooted vines need to be stored for a longer period, place them in a covered grape bin with moist sawdust and find a cold storage facility to hold them for the necessary time. If they are bare rooted and not boxed, they should be buried in moist (not wet) sawdust.

Quality control on the plants (especially grafted ones) can be done at this time. Now is when you should cull out any vines that do not meet minimum standards.

Perform a quality check on at least a few sticks in each bundle (see Chapter 11 on plant materials for criteria). If any of these conditions are not met, the vine should not be planted. It seems like every grower has an idea of what constitutes an acceptable dormant grafted grapevine. Root number and length can vary greatly between nurseries or even between batches from the same nursery, but as a general rule, the more and longer roots on a vine, the better. Better to trim roots than wish you had more. The rootstock should be properly disbudded at the scion should have two or more buds. Rootstock and scion diameters should be a closely matched and a minimum of 3/8th inch. The nursery should be contacted right away if serious quality problems are found. The graft union should be given a flex test in different directions, using pressure to bend the rootstock and scion between fingers and thumbs. Weak grafts will break almost immediately and should be counted for replacement.

One of the worst things that can happen to a vineyard is a mix-up in materials occurring either at the nursery, during shipping or just before planting. The problems that this can cause in the field do not require explanation. Nothing can be done about mistakes made at the nursery since dormant vines are indistinguishable by variety. But at the vineyard keep materials well organized and clearly labeled. Planting days are often chaotic and it is very easy to mix up bundles.

Preparing for planting

The day before planting, the roots of bare rooted vines can be soaked in water for 24 hours. A large trough or tub is good for this purpose. If possible, one day's worth of vines should be treated. If the roots are too long they probably need to be pruned. When you are using laser or machine planting to set the vines, this will be necessary for the machine to operate properly. Even if the vines are being hand-planted, they should be pruned back to a "reasonable" length (see the Planting section, below). The general rule when you are selecting your root length is that when planting the vine, you have to dig a hole that is deeper than the length of the roots.

Check the weather and the condition of the soil before planting. It is neither fun nor sensible to plant in a muddy field. The soil should be moist, but neither powder dry nor sticky. It should not stick aggressively to a shovel blade. If planting conditions are correct, the quality of the work will be much better and the job will go faster. Sunny, hot weather can dry out the exposed roots of a vine that is left lying on the ground for just a few minutes. Keep the vines in water right up until they are planted.

The scion will vary in length depending on the nursery. Often it is a two-bud scion, which will yield two shoots in the spring. You should retain both of these. Sometimes there will be more buds, in which case you need to decide how many to leave. This will depend on your first-year training method; for example, whether you are going to start training with two shoots or let the new vine "bush" with many shoots. This topic will be discussed in more detail in the section on first-year management (see Chapter 19).

Planting high-quality vines is a critical component for developing uniformity in the vineyard, and you should aim for a successful new vine "take" of 95% plus for grafted vines and even higher for own-rooted vines. If your take is low and more vines are not immediately available to plant, then your vineyard will be starting out with vines planted in two or more seasons, which will upset uniformity. Having a sound vine only gets you halfway to a uniform vineyard. Adopting correct planting techniques is equally important.

Planting

This is where an idea is transformed into a vineyard and it is a very exciting moment. Hopefully the weather will cooperate and allow the planting to proceed on schedule. Planting days are generally long and hard and there is a lot to do and think about, so the more you can prepare ahead of time the easier it will be. Mix-ups in the barn or field of varieties, clones and/or rootstocks will be frustrating and costly. There are many ways to successfully plant a vine, but few single operations in the life of a vineyard are as important and so it must be done correctly. A great deal of effort has been expended to get a healthy vine, so don't jeopardize the investment by falling back on sloppy planting technique.

If the conditions are right for a laser planter, this is probably the most effective and stress-free planting method available. Like all machines, laser planters work best on flat and broad surfaces. Hilly, uneven and rocky sites pose more of a challenge. Laser planters use sensors and geographic positioning system (GPS) technology to plant straight rows with vines that are equidistant in the row and aligned precisely up and down, across and diagonally in the field. The result is a perfectly configured vineyard that is well worth the added expense of having a professional plant the vines.

Most laser planters charge by the number of vines and rows, plus a travel/set-up fee. The follow-up after machine planting is also important; the field should be checked for misses, and the height and placement of the vines. There are commercial laser planters in operation in the larger wine-growing districts of eastern North America, particularly Ontario. The operator of the laser planter will have strict requirements for the condition of the field before he begins work. Find out what he wants in the autumn before



A laser planter gives straight rows in all directions

planting and follow his instructions to the letter. If the field is not up to his specs when he arrives, he will charge for downtime until it is. It's a good idea to send photographs of the field before he comes to make sure that it is properly prepared.

Tree planters are not recommended unless you can get a highly skilled and experienced operator. These planters tend to wander off line and leave hourglass rows, uneven vine spacing, and variable alignment across the field. If they hit a rock they will jerk out of line, which is very hard to correct. They work best on flat, even terrain with few or no rocks.

A backhoe should never be used to plant vines, nor should any "mixing" of soil occur during the soil preparation or planting process.

Hand planting is still a very practical and effective way of getting vines established. It is the only way to plant a vineyard if the trellis and irrigation systems are installed before planting. Hand planting is quite labor-intensive and must be done properly. Planting teams should include a hole-digger, a person with a 5-gallon bucket of water and vines who will plant and tamp, and a person to follow them for quality control.

A sturdy narrow-width planting shovel should always be used. A post-hole digger will also work. Sharpening the digging edge will make the job easier. A proper hole should be dug;

do not simply use the shovel as wedge, rocking it back and forth to make an opening. A plug awl such as those used for planting Christmas trees is not a good planting tool for vines. Power augers are acceptable if the soil conditions meet certain specifications. If the ground is too wet, the auger may glaze the soil and create an impenetrable layer that could inhibit root growth. If it is too dry, the soil cannot be lifted out of the hole properly. Augers can be either hand-held or 3-point mounted and PTO-driven on a tractor. They are slightly faster than hand planting but are noisy and smelly. A 4-6 inch bit is okay in most situations. A 12” bit is too wide and requires extra work to dig and fill and will often settle too much.

The hole only needs to be wide enough to get the plant in vertically, and deep enough so that all the roots are pointing downward. The bigger the hole, the more effort that is required to dig it and backfill it. Every vine should be placed against the same side of the hole, in line with the row. After the hole is partially filled, pull the vine up to the proper height. This little lift will ensure that the roots are pointed downwards.

The graft union should be 3-4 inches above the soil surface after settling. This is important to prevent scion rooting, which can occur even if the scion is not physically covered with soil. Colder vineyard sites that will be hilling up to protect grafts unions need to be particularly aware of graft union location – not too high that a berm cannot cover and not too low that taking away soil in spring will still leave the graft union covered. If a vine scion roots, then the rootstock may die, leaving the scion directly or own-rooted and hence exposed to phylloxera injury. Constant monitoring after planting to prevent scion rooting will be necessary, especially on vines that are hilled up to prevent winter injury.

The roots must be positioned downward and there should be some space between the ends of the roots and the bottom of the hole. Do not “J-root” the vines as this will inhibit growth. Trim the roots if they are too long for the depth of the hole. The roots of plants from the nursery may vary in length and number. A #1 plant should have 6-12 main roots that are 12” to 24” long with a good fibrous mass. Nobody wants to dig 2-foot holes, so root pruning to 12” is perfectly acceptable. However, to establish a healthy vine, try to use as much of the original root mass provided by the nursery as possible. If you make a 12-inch hole, fill in 3 to 4 inches and then tamp down with a device (a 12 x 2 x 2 inch stick is a good tool) to pack the soil around the roots. Then fill in another 3 to 4 inches and tamp, and repeat until the hole is filled to slightly above the surrounding surface line, so that the soil can settle evenly.

Very specific instructions followed by a demonstration and constant monitoring and quality control will be necessary when working with an inexperienced planting crew. Even an experienced crew must be checked regularly to make sure that their work meets your standards. Rotate the members of the team (diggers and planters) periodically so that the work is evenly distributed. This is hard field labor, so using family and friends is not recommended except for small hobby plantings.

Regardless of whether machine- or hand-planting is used, the vines must be set in a straight line. They should not wander away from the center line or lean away from the vertical plane of the row. This will be crucial later on to the efficient operation of equipment, especially grape hoes, herbicide booms, tunnel sprayers, mowers and harvesters, which prefer vines to be properly lined up. Hoes and mowers will take out vines that are off-center and harvesters will not work as well. Achieving proper placement begins with planting and will continue during vine training.

Most or all soil amendments should be done before the vines are planted, but nevertheless growers put all kinds of material in the planting hole at this time, including fertilizer, compost,

water absorbent materials, and mycorrhizal fungi. Microbial inoculants may be used if the soil is deficient in fungi and bacteria, especially in rapid turnaround replant situations. Fertilizer (if needed) is best added after the vine is planted, through fertigation or hand application. Super-absorbent polymer (SAP) products such as Watersorb can help the soil retain moisture for the benefit of roots under dry conditions. It is important to understand exactly why an amendment is being added to the planting hole instead of during the site preparation phase. Consult a knowledgeable soil expert when in doubt.

Timing

The timing of planting is extremely important. Probably the most critical considerations are soil condition and spring frost. Unpredictable weather in the spring can make both of these issues real nail-biters. If you have vines and a crew or laser planter ready to go and it rains, you are faced with a tough decision. A wet soil will not pack as well around the roots, often leaving air pockets that will dry out the roots later. If the soils are too dry and irrigation is not immediately available, the vines will suffer from water stress. The ideal soil in the root zone will be moist and somewhat crumbly in the fist. This should be checked just before planting begins.

Hopefully climate research during site evaluation will have yielded an approximate last frost date for the site, after which it will be relatively safe to plant, but there are no guarantees. Efforts to find a site with minimal frost risk will begin to pay dividends here. However, if new vines do get frosted, secondary shoots will likely push. A dry-farmed vineyard should be planted as early as possible to take advantage of spring soil moisture. You do not want to plant too late in the season either. Planting in June or July reduces the amount of time the vine has to develop during that summer and the time it has to harden off for winter. Fall planting should be avoided.

Checking your vines

No matter what type of planting method is used, make sure the vines are properly and securely set in the ground at the correct depth. The vine should be standing straight up in the row center with the graft situated about 3-4" above the ground, with the soil well packed around the roots, which should all be in the downward position. It is important that your workers plant the vines correctly, because it is very hard to make adjustments afterwards. Quality control must be maintained during the entire planting process to ensure good take and uniformity.

Maintaining an accurate record of the various components of each vineyard block is essential to develop a history of the vineyard and track any vine problems that may develop after planting. A detailed map of the planting should be drawn up that specifies all of the distinguishing components of a given block including variety, rootstock, clone, nursery, date and method of planting (if more than one is used) and any other data relevant to the history of that block. The original map almost always gets lost or so wet and dirty that it becomes illegible, so it is a good idea to make additional copies and store them in a safe place. The original nursery identification tags can be used to mark changes in variety, clone and rootstocks across the vineyard. Numbered and labeled end-post tags bearing this information will be helpful to crews, winemakers and vineyard managers.

You now have a vineyard! You are a wine grower. Now you can start nurturing the vines towards fine wines.

Chapter 16

Trellis and Training Systems



Lyre system has two vertically divide, upward trained canopies with a clear center area. Note many wires.

The French viticulturist Dr. Alain Carbonneau invented the Lyre trellis system. He explains the importance of the vine canopy, and by extension the trellis, very simply: “The choice of the canopy is part of the taste of the wine.” It is in the nature of most grapevines to grow upwards. If you go into the woods you will see what prolific climbers the wild vines are, often stretching well into the tops of tree canopies. They are seeking light and if they have enough nutrients and water, the sky seems to be the limit. To tame this growth habit, for centuries man has been cultivating vines on trellises.

Various trellis systems have been developed, based on either a horizontal or a vertical design. For many years the standard system in California was a 2-wire vertical trellis, sometimes modified with a cross-arm. It couldn't be any simpler (except for a 1-wire system). With the arrival of a new bio-type of phylloxera and the downfall of the widely used but susceptible AxR#1 rootstock in the North Coast counties, California sprawl has given way to a vertical shoot positioned (VSP) system that utilizes many more catch wires. This system accommodates a single, vertical canopy. A horizontally divided system that will support multiple canopies, such as the Lyre and the Geneva Double Curtain (GDC), are more complex and therefore more expensive to construct.

In the East, traditional trellis systems include the four-arm Kniffen, the Hudson River Umbrella, and top wire trained systems such as the modified Keuka High Wire and Geneva Double Curtain. All of these have fallen out of favor in modern wine vineyard development.

Trellis and training systems are closely linked in their development and use. The trellis system must accommodate the choice of training method. In commercial applications it is usually cordon training/spur pruning or head trained/cane pruning. Vine training directs the structure of the vine to a desired form that will fit on the trellis. The most suitable trellis system vineyard should be determined by the site evaluation and estimated soil capacity and ultimate vine size. Vine size will impact planting density, which will guide trellis choice. For example, a horizontally divided system like GDC or Lyre needs more space between rows (usually 10-12 feet) to allow for tractor access. On lighter soils in cooler areas the VSP may be the best choice. The training system will be based on the variety, and the size and vigor of vines, local traditions and other considerations. The ideal trellis should be full, but not so crowded that the vines infringe on the space of their neighbors. The standard for fine wine vineyards (with some variations around the world) is the vertical shoot positioned system. It is important to determine the most appropriate trellis system before the vines are planted, because downstream changes can be complicated and expensive.

Climate also impacts trellis choice. In warmer areas a system that spreads the canopy helps to provide protective shade to the fruit zone and prevent sunburn. In cooler areas where more sun exposure is desired to promote ripening and reduce problems with disease, the thinner VSP may be the best system. Local knowledge will help to guide your trellis and training choices.

If soil capacity and vine vigor are unpredictable, a good option is to develop a trellis system that can accommodate both VSP and a vertically divided system called Scott Henry. Then if vine vigor is lower than expected, vines can train to VSP. If it is higher you can divide the canopy vertically to Scott Henry or Smart-Dyson, redesigning the trellis to fit the larger dimensions of the system. Study the various training and trellis systems available and pick the one that best meets your wine style goals and site characteristics.

Canopy management will be one of the most important quality practices in each vintage so the trellis must support all canopy management objectives. No matter what system is chosen, the purpose, design and strength requirements of the trellis system must be determined. Reviewing practical vineyard guides such as *Sunlight into Wine* and the *Wine Production Guide to Eastern North America*, talking to vendors, and visiting growers who use a particular trellis are good ways to learn and will give you the opportunity to study working examples.

Considerations when choosing a trellis system

The trellis is what holds everything up so it needs to be well designed, built using the best possible materials, and properly installed. The trellis system is a reflection of the expected vigor of the site and the intended style of the wine. Big vines need a big trellis. Smaller vines will require less structural support. Some training systems, like the traditional head trained-cane pruned method, are freestanding. Overhead trellis systems such as the pergola require very substantial support structures. The trellis system you choose must be the right one for the particular vine training system you are using.

Over time, certain trellis and training systems have been adapted to specific grape varieties. Most native and some hybrid varieties are known for their downward cascading growth habit, and varieties like Concord and Niagara are almost always grown on a high wire system in which shoots are trained in a downward position. Inter-specific hybrids and the Minnesota hybrids are well adapted to a high wire cane or cordon system trained to 60-70 inches. Vidal, which makes a superb white wine, appears equally comfortable on a high wire or low cane/cordon system. Single high-wire systems are less expensive to install and maintain, and can produce very high quality fruit. Because of their downward configuration and wider girth near the ground, more space between vines is required (usually 8-12 feet) and weed control may be more difficult when the shoots reach the ground. Some hybrids grown for a higher price point, such as Chambourcin, are being trained to VSP to improve performance and wine quality. Tradition and aesthetics can also play a role in trellis choice; over the years certain systems and varieties have been matched, and usually for good reasons. Some people have a strong preference for the appearance of wood posts over steel. Nonetheless, it is important to evaluate the options based on characteristics of the site and its particular needs.

The type of soil in your vineyard can affect the installation and performance of a trellis system. It is harder to get line posts into rocky soils so steel stakes may be preferred. In sandy soils it can be difficult to install stakes that do not wobble. Soil chemistry and moisture will affect the longevity of stakes regardless of what they are made of. These factors should be taken into account when choosing and installing a trellis system.

Materials

Vineyards are planted to last a long time and the trellis system must do the same. Pay close attention to detail when choosing your materials and installing the trellis because this will directly impact longevity. A good trellis system usually looks like a good trellis system, and

while it will eventually disappear into the vine canopy, it must continue to do its job. Keep in mind that a well-designed trellis system will enhance the aesthetic appeal of a vineyard, which is not an unimportant consideration, particularly in winter and early spring when the trellis is fully exposed.

The rule when selecting materials is: get the best and most durable components available. The long-term nature of a vineyard demands this. Make no mistake about it, as with almost all products, there is good and bad design and quality in wire, stakes/posts and other trellis materials. Replacing broken stakes and wire, fallen trellis and so on is frustrating and expensive, and in the long run it will be cheaper to invest in high-quality materials. That means the proper gauge (thickness) of end posts, line stakes, and wire; the correct length of dead-man anchor, high-quality training stakes, etc. This rule holds even if – or especially since – the price of everything from fuel to steel has been skyrocketing. Use some common sense rules to keep within your budget. Check prices frequently, order well in advance and if possible in quantity with others, and make sure that what is delivered is what was ordered. The inexperienced eye cannot tell the difference between 12- and 14-gauge metal stakes, so use a micrometer to make sure that the proper gauge of wire or stake was delivered. Dealing with a reputable vendor will help you to get the correct materials, but will not guarantee it.

Environmental conditions will affect the longevity of the trellis system. Soil factors like moisture, salinity and pH can all shorten the working life of both wood and steel posts. Salt air in coastal areas may damage the trellis wire and other metal parts. Proper measures should be taken against known threats. This could mean investing in more expensive materials, such as galvanized steel stakes. The alternative is to replace parts when they are damaged, which can be costly and time-consuming in a mature vineyard. If a trellis fails under high wind conditions, for example, it will very likely be near harvest when a full load of fruit is on the vines. It is very difficult to make repairs at this time and fallen trellis will disrupt harvest operations. This is where preventive measures can pay real dividends. Wood and metal stakes usually fail at ground level and will sometimes hang freely on the wires, making it hard to detect a problem. If one broken post or stake is found there are probably others; a kick or bend test will help to locate them.

Line posts

Pressure-treated wood (usually yellow pine) generally 3-5” in diameter, has been the traditional choice for line posts. Be aware that if the wood is too dense, the CCA preservative will not penetrate well. Cut the ends of a few posts prior to installation to check for sufficient treatment depth. A good supplier will provide certification of their treatment standards. An important word of caution: CCA-treated posts that are being replaced should never be burned because of the arsenate content in the preservative.

Non-commercial, self-made posts from locust or other local trees is not recommended. Besides not looking very professional, they are hard to install properly and can easily fail.

Steel has recently been gaining in popularity. Steel posts will generally be about 2 inches in width, various thicknesses (gauge), stake design and notch pattern and whether you want galvanized or non-galvanized steel. Every one of these factors will have implications for durability, strength and wire placement. There are some very poor quality steel stakes on the market and these must be avoided. The notch positions on steel line stakes must be correctly spaced. Do not get stakes notched to the point where the stake enters the ground since this

weakens the stake at a critical location. The posts should be strong enough to hold a full crop and withstand strong winds.

In other countries fiberglass and concrete posts are used, but they are not readily available here. For a specific canopy width, there is a specific width for the steel or wood post that will best accommodate it. There are wire-holding assemblies that can space wires more widely apart to accommodate a wider canopy, or you can simply use wider wood posts.

Fixed wires are attached to wood posts using galvanized staples and should allow for movement of the wire for tensioning. Movable catch wires are attached using galvanized nails, “J” staples, clips, or other types of wire-holding devices. One problem with wood posts is keeping the wire fasteners in place, as they tend to work loose after a few years. Install them at a downward angle and slightly off a vertical alignment. The fruit wire should be installed on the windward side of the trellis.

In deciding the length of the stake, remember that they should be driven into the ground to a depth of at least 2 feet, and perhaps more in sandy or other loose soils. If the soil is too sandy, the post will always wobble, and only a cement casing will hold it fast. If the relative vigor of the site is uncertain, a 10’ line stake – 3’ deep and 7’ above, just in case a decision is made to vertically divide the canopy. This will offer flexibility to switch between VSP and Scott-Henry. It’s always better to have too much trellis than too little. Most VSP line posts are 6’ high 20’ to 24’ apart, but their placement should be dictated by the distance between vines, with each post falling evenly between vines. Vines should not be placed next to a post, especially if you are planning to harvest mechanically.

It is recommended to get wood posts with a pointed tip for ease of insertion. Posts and stakes should be pounded or vibrated rather than augered to minimize wobble once they are in.



Steel end assembly with dead man anchoring system

End posts

End posts and assemblies bear the brunt of the stress on a trellis and therefore should be stout but not over-built. Complex end assemblies usually fall apart over time and are difficult to repair. The length of row will impact the type of end assembly needed. For most applications, a 5-6” diameter wood post or a round or angled steel end post with a dead man anchor will suffice. End posts should be planted at least 3’ in the ground, and more is even better. Some vineyards drive 10’ end posts (wood or steel pipe) 4’ or more into the ground and forego the anchor. Like line posts, end posts should be pounded and not augered for the best results.

End posts should be installed at the correct angle, typically 15-30 degrees from vertical. To get the proper alignment of a row of end posts, install them every 10-15 rows and run wire from the bottom and top position of each post. Use these wires as guides for the inside end posts while continuing to check the alignment with a level and by eyeballing the line. Remember that with a steel U-channel end post, the open end should face inward or else wire attachment will be very difficult.



Wood end assemblies on Long Island

Anchors should be installed at the right distance from the end post and screwed straight into the ground. Larger diameter anchors are used in lighter sandier soils and smaller anchors in heavier, clay-based soils. A simple straight bar is a good tool for installing anchors. There are attachments that can fit on a PTO-powered auger to drive the anchors. They should go to full depth with the anchor loop or eye to ground level. Rocks are often a problem with anchor installation; it may be necessary to move the anchor closer to or further from the end post until an unobstructed piece of ground can be found. Anchor wires should be at minimum the 12-gauge hi-tensile or braided wire for this use. A double-wrapped anchor wire can be twisted and tightened into a single wire with a metal bar. Some growers place a white PVC sleeve on the anchor wire to increase visibility and help avoid equipment damage. Trellis suppliers and manufacturers such as Gripple offer anchor systems that are designed for this vineyard application.

Installation

Installing trellis systems is a big job and usually very time-consuming. The ease and pace of installation will depend to a large extent on the soil and topography of the site. A steep rocky field presents the most difficulties. Layout and installation are much easier on flat, sandy loam soil, as for example on Long Island. A trellis or fence installation company can be hired to do the work. It is important to have straight rows for both practical and aesthetic reasons. Stakes should be aligned both up and down the row, across the field, and diagonally. A surveyor can help to achieve this effect and is well worth the expense. Crooked rows are looked at somewhat askance by wine makers and (perhaps more importantly) by customers. They also make equipment operation more hazardous. The placement of the stakes must be done meticulously, whether or not the vines are already in the ground. Use a marker for the position of each post or stake.



Using a vibrator to install metal line stakes

Trellis installation can be extremely hazardous. A post pounder exerts tremendous force on a stake or post, and can cause it to split, splinter, shatter, or fly out of position. Strict safety precautions should be taken during post installation. Hardhats, heavy work gloves, and eye and ear protection must be worn by anyone working near the post. Protective sleeves that separate the post from the operator can be used. Get expert advice if you have never done this before, and practice on a few posts first. Post pounding by hand is hard work, but not quite as dangerous.



Proper equipment and method to install end posts

Vibrating devices can be used to install metal stakes in soil that is not too firm. Find the method and equipment that will work best with your soils and type of post.

In rocky soils, the posts or stakes may not go in easily. One option is to change the placement of the stake, moving it up or down the row until a suitable spot is found. Otherwise hand dig a hole and if the stake will not reach the proper depth, trim the top of the stake to the proper height. On slopes the stakes should be aligned to a vertical position regardless of the angle of the slope.

Wire

Trellis installers develop a very close relationship with wire during long days working in the vineyard. First and foremost, a word about wire safety. There is a rule in nature that the sharp end of a wire will always try to find an eye to poke. When working with wire, safety glasses and good gloves are an absolute must!

Wire, like your posts, needs to be strong enough to hold a full crop and withstand strong winds. For an acre of 8' x 4' VSP with one fruit wire, two pairs of movable catch wires and two permanent wires, it will be necessary to unwind, splice and fasten over 38,000' of the wire. Wire is essential and must be understood to be handled properly. It is wound under pressure into heavy spools usually weighing about 100 pounds or more. Because there is tension in the spools, the wire will appear to have a life of its own and if not unwound properly, it will unravel and cause a tangled mess only comparable to a fisherman's worst nightmare. Once this happens, the roll must be scrapped. Use a "spinning jenny" to properly dispense the wire, with a man carefully managing the wire as it comes off of the spool. Multi-tiered jennies can dispense more than one strand at a time.

Walking up and down the rows pulling wire is tedious and strenuous. However, using an ATV or other vehicle is not recommended, because feeling the tension in your hand when a tangle occurs at the jenny is necessary to avoid calamity. Here's a helpful tip: whenever both hands are needed to work, stick the end of the wire in the ground to hold it fast.

A lot of wire splicing will be necessary and growers usually have a distinct preference for certain fastening and splicing materials and methods. A double nicopress splice is very unlikely to fail. Regardless of the system you use, the correct crimping tool is necessary. Wire should never be kinked or wound too tightly.

Wires need to be attached to their wood post or steel stake. A come-along with a wire gripping device is a crucial tool for tensioning wire in many applications. Other handy tools are a fence hammer, vice grips, and heavy-duty wire cutters. Fastening and holding devices for your stakes, such as staples in wood, have to be strong and fast. Tensioning devices or wire strainers are often used on the fruit wire and sometimes the catch wires. The fruit wire should be fastened but not bound to their supports. Catch wires should retain freedom of movement for shoot positioning later on. In wood posts, and angled nail, J staple or plastic wire sleeve can hold the wire in place. The fruit wire will usually be high-tensile 12-gauge wire. Catch wires can be lighter 13- or 14-gauge soft wire since they don't have to carry a load.

Wire can come with various protective coatings. At a minimum be sure to buy high-quality galvanized wire. Repairing broken wires in a mature vineyard is an exasperating job that you must fervently hope you will never have to do. Using good wire can help to avoid this. Fruit wires need to be fully tensioned to hold the weight of the vine and crop. Catch wires can be more loosely tensioned, whether fixed or movable. Movable wires need to have slack to function properly. A common technique is to add a 24" chain to each end of a movable catch wire, which can then be adjusted to a nail positioned at the appropriate height on a wood end post.

Height of the fruiting and catch wires

There is plenty of debate about the optimal height of the fruit wire for high-quality wine production. The standard on VSP systems in the East is 30-36". This allows for airflow below the canopy to help dry it out from rain or dew and keeps the fruiting wood elevated enough to offer some frost/freeze avoidance. It also makes it a lot easier to move between rows (just try to squeeze under a 20" wire!) and keeps work in the fruit zone within easy reach.

If a high wire cane or cordon system is being used, the fruit wire position can be established at 60-72". A pair of catch wires may be placed about 2' below the fruit wire to tuck the canopy in; this will keep it from sprawling into the row and getting tugged by passing tractor tires.

Many high-quality vineyards are lowering the wire for expensive red *vinifera* grapes to 20-24", which is the practice in Bordeaux and Burgundy. The purported advantage is greater heat availability at the lower height, in terms of both reflected and radiant heat stored in the soil and released at night, which can help to push the vine's physiological processes. In higher-density vineyards (typical of certain regions in Europe), to reduce the between-row distance the overall canopy height is lowered, thus necessitating a lower fruit wire. This approach has its pros and cons. Having a low fruit zone may allow the grapes to pick up more heat, but it also places the clusters in a more humid and frost-prone environment and closer to splashing disease spores. Another important consideration is the relative ease of working at 36" versus 20". Bending over all day to remove leaves or pick grapes is hard on the back and may lead to worker's compensation claims. It would be worthwhile to research this point and talk to growers who have experience with different fruit zone heights.

Positions for wire placement can be studied in books such as *Oregon Viticulture* and *Sunlight into Wine* and in established vineyards. Notched stakes have an advantage over wood since they allow all the wire positions to be adjusted. The first catch wire is positioned about 12" above the fruit wire, the top catch wire about 6" below the top of the stake and the middle wire in between the top and bottom wire. Some growers use three pairs of fixed catch wires for VSP, while others use two to three pairs of movable wires. There are many variations so seek the one that is most comfortable and efficient.

All divided systems have their own peculiar wire position and numbers. For example, a vertically divided system like Scott Henry or Smart Dyson needs an overall height of 7' to accommodate both the higher and lower leaf panels. The fruit wire is also moved up to leave enough room for the downward-trained shoots. The Lyre system with its two vertical panels requires more wires than any other system. More wires mean more shoot positioning, which adds to the cost of maintaining the vineyard.



Use a proper training stake to create a straight trunk

training stakes regularly, fastening them loosely with expandable material to prevent girdling. Do not use string, wire, ag-tyes or other non-expanding materials.

Training stakes

As an extension educator I look for cues that a vineyard development project is serious and one is the choice of training method and materials. Training stakes are a requirement in a high-quality wine vineyard. This is simply another way of saying that straight trunks are a requirement. As more and more vineyards are being mechanized, equipment such as harvesters demand straight trunks for optimal efficiency. A properly trained vine also looks a lot better. In young vineyards, the steel pencil rod training stake offers a stiff target for the sensor arm on a grape hoe and protects the tender shoots. While bamboo stakes have been the most common training stake for years, a rolled-steel pencil rod or re-bar is much stronger and more durable and can be reused in future fields. String training should not be considered a viable option.

Training stakes must be securely fastened to the fruiting or irrigation wire. Vines should be tied to the

Scheduling your trellis installation

When to install a trellis system depends on the timing of other parts of the vineyard development project. If the vineyard is being laser or machine planted, the field has to be left open for tractor access and the trellis should be ready to be installed as soon as the vines are planted. Sometimes growers will allow their new vines to grow out (in a bush shape) in the first year and install the trellis in the winter or spring. However, allowing vines to sprawl on the ground is not a good way to start their life. If drip irrigation is being installed, the trellis must be in the ground before or directly after planting. All of the necessary materials, equipment, personnel, and services should be in place and ready to go as soon as the vines are planted.

Make sure that you order all essential vineyard materials and supplies well in advance of their being needed. Unfortunately, short supply lines, on-time inventory systems, and the lack of raw materials have wreaked havoc in the materials supply sector. The sooner an order can be put together with a reliable vendor, the better are the chances of receiving the materials on time.

Trellis materials are heavy and bulky, and will often be delivered in large bundles on a flatbed truck. Be prepared to unload and store the material, and then to distribute it into the field. Have the necessary equipment and facilities in place to do this safely and efficiently. A proper work area will greatly enhance the process.

Chapter 17

Equipment and Technology

It is possible to grow wine grapes with very little equipment and technology. The need for specialized equipment and technology increases with the size and wine quality goals of the vineyard. There are some tools and pieces of machinery, however, that are absolutely necessary to get essential tasks done in a timely and correct way. These represent the minimum requirements that will keep everything going on the farm.

The tractor

The tractor is the heaviest, most expensive and most important piece of equipment that you will own. It must have the power take off (PTO) and horsepower at the drivetrain to power up hills under heavy loads. Implements are rated for PTO horsepower. Make sure that there is enough available for the most demanding piece of equipment used. Many implements require hydraulic power and tractors need to be rigged for this application. All wheel drive will be necessary for hilly sites. A positive-pressure cab with air-conditioning is highly recommended, especially since a lot of spraying is necessary in the Eastern climate. In the absence of a cab, a good ROPS (roll-over protection) system is a non-negotiable requirement. Purchase a tractor that will fit comfortably into the row width you select; 6-12" of clearance to the rear tires is normal but slopes will affect this decision. The more slope (and especially side hill), the more width of row and tractor will be necessary.

How many tractors do you need? One to start with, but as the vineyard size increases to over 15-20 acres, a second tractor may be necessary to perform multiple and simultaneous operations. When the heavy spray season begins, it's very convenient to have a dedicated spray tractor. This can also serve as a reserve in case the first one breaks down. The second tractor could be a used machine with less horsepower for lighter duty operations such as mowing.

On hilly sites many growers are moving to crawlers equipped with PTO and rubber tracks. These offer greater stability and much lower soil compaction, and some even come with steering wheels instead of the traditional dual-lever steering system.

Vineyard sprayers

The vineyard sprayer will be another significant expense and there are many types and brands to choose from. As the urban/agricultural interface increases, tunnel type sprayers are becoming more prevalent. They look like a shower stall on wheels and can capture excess spray material, re-circulating it through filters for reuse. These are environmentally friendly machines and, while the initial outlay may be higher, they are cheaper to operate in the long run.

The industry standard is an airblast sprayer; this is effective but delivers a large spray plume, which could raise concern among neighbors and may not be the most efficient delivery system for your purposes. Purchase a high-quality sprayer because grape disease will pose a serious problem in most years.

It is strongly recommended that growers read *Effective Vineyard Spraying* by Dr. Andrew Landers, a spray engineer at Cornell University. This book describes equipment and methods in great detail.

A separate and dedicated herbicide sprayer and accessories are necessary for herbicide applications. Never use herbicides in a canopy sprayer for obvious reasons.

Quality (once again)

Reliability, durability and serviceability should be built into every piece of equipment purchased. In most cases, you get what you pay for. If the intention is to be in the vineyard business for the long haul, purchase the best possible equipment and plan for the future. Under-designed or poorly constructed equipment will lead to frustration and possible damage and safety hazards. Remember that, according to Murphy's Law, a piece of equipment will break down exactly when it is most needed, so potential service and repair costs should be a critical consideration in purchasing equipment. How fast can a broken sprayer or tractor be turned around? In our climate a single missed spray application could result in significant crop loss. Access to a backup tractor and sprayer is never a bad idea, but borrowing and lending equipment is to be discouraged.

Look at what other growers are using and talk to them about the pros and cons of a particular brand before deciding what to purchase. Visit high-quality vineyards and see what pieces and brand of equipment they have, and ask who the best suppliers are.

The ABCs of purchasing equipment

There is a right tool for every job and finding these tools will make the job easier, faster and better. Most people persist in learning the hard way – by struggling, swearing, breaking something or worse still, hurting themselves by using the wrong tool or equipment. It is much more sensible to select the right tools and materials in advance. In the long run they will be better, more durable and safer. Good tools and equipment deserve to be treated well, so protect them by storage in a proper facility, from the tractor down to spare O-rings.

Order equipment well in advance of the time they will actually be needed. Many problems, from supply chain shortages to dealer incompetence, can delay the arrival of a much-needed tool or piece of machinery. If you procrastinate, it will be the vines and your budget that will suffer.

A starter list of essential vineyard equipment might include the following:

- Tractor (4WD or 2WD) or crawler with PTO and cab with a loader (bucket and forks)
- Post-installation device
- Wire dispenser (spinning jenny) (photo: spin jen)
- Post hole auger
- Vineyard sprayer – air blast or shielded/tunnel style, 3-point or tow-behind
- Herbicide sprayer with boom or Enviromist-type applicator (a separate sprayer that should never be used to apply other materials)
- Mower/brush chopper (knives vs. hammers)
- Seed drill or spreader
- Cultivating implements (including hill up/take down) – plow, disc, harrow
- Grape hoe for vine row weed control and hilling up
- Pickup truck
- All-terrain utility vehicle such as a gator or ATV
- An equipment shed to store all of these essential items out of the weather

Vineyard Equipment and Materials

Michael Schmidt, Owner

Spec Trellising

Ivyland, Pennsylvania

<http://www.spectrellising.com/>

Product Selection

When installing a vineyard trellis, particular attention should be paid to selecting the proper materials for your chosen trellis system. For example, two popular training systems – VSP and the High-Cordon system – generally require 8’ line posts, with 2’ driven into the ground. Divided canopy systems such as Scott-Henry and Smart-Dyson require 9’ posts. If the grower suspects that his vineyard is a potentially high vigor site, or that the variety planted might be vigorous, a 9’ post may be better suited to his needs. The additional 12” of post would then be available should the grower later determine that he wants to convert his non-divided system to a divided canopy system. End posts, regardless of the training system, should be **POUNDED** at least 3’ into the ground. Studies performed at the Sunraysia Horticultural Center in Australia have concluded that end posts should be driven vertically into the ground, not at an angle. Vertical end posts are stronger and easier to work with than angled end posts.

Steel vs. Wood Posts

Wood posts have long been preferred in vineyard in the U.S. This could be due to the fact that until recently steel posts could not be easily obtained except along the West Coast. As they become more readily available, the popularity of steel posts has increased significantly in many areas of the U.S. The major difference between steel and wood posts is the **LABOR** costs for trellis installation. Wood posts can be up to 4 times more expensive to install than steel. This includes the costs not only of planting the posts in the ground, but also of the hardware necessary to secure trellis wire to the posts. Most steel line posts today have built-in wire slots for securing trellis wires. These slots provide many options for wire placement.

To determine which gauge steel line post should be used, factors such as expected crop loads, training system, general wind conditions, line post spacing, and topography should be considered. Stronger posts must be selected when line posts are spaced upwards of 24’ if the site is generally exposed to cross-row winds, or if the site is situated on an exposed hillside, or if the expected crop loads are significant. Galvanized posts, while more costly, generally last longer than bare steel posts, but do not look as “natural” in the field. Like steel line posts, steel end posts offer similar benefits when compared to wood.

Wood posts are typically less expensive to buy than steel, but more time consuming and therefore more costly to install. As with steel posts, there are different types of wood posts available. Most of the wood posts used in vineyards are chemically treated (for long-life) and are made either of lodge-pole pine or southern yellow pine. In general, red pine posts should be avoided due to their inherent weakness and brittleness. Wood line posts are generally 3 to 4 inches in diameter and 8 to 9 feet tall while end posts should be 5 to 6 inches in diameter, and 9 to 10 feet long. Posts should be round in shape and blunt at the ends.

Trellis Wire

The most common wire sizes for wine grapes trellises are 12 ½ gauge and 14 gauge wire. The latter should only be used for non-load-bearing functions, such as irrigation and foliage wires. Cordon wires should at least be 12 ½ ga. Polyester wire is gaining in popularity due to its ease of use and rising steel prices. Polyester works well for moveable catch wires due its ability to stretch when being moved. Polyester should be avoided when steel posts are used.

Vineyard materials continued >

Schmidt: vineyard materials . . .

Wire Joiners: Retensionable vs. non-retensionable

Fruiting wires should be fastened to end posts with retensionable wire joiners. This enables the wires to be retensioned when they slacken. If a non-retensionable wire joiner such as a crimp sleeve has been used, the wires need to be cut and rejoined together to tension. Crimp sleeves are best employed where wires can be twisted to tension (soft wire only) or when their installation will be permanent and they never need to be retensioned. High tensile wire should never be twisted to tension.

Timeline for Ordering

At the minimum, end posts, line posts, fruiting wire, vine support stakes, ground anchors (if used) and irrigation materials should be on-site at time of planting. Immediately after planting, vine protectors such as grow tubes or milk cartons can be installed and secured with a vine support stake. At that time the end posts, line posts, fruiting wire and irrigation wire (if being used) should be installed. It is always best to fasten the vine support stake to the cordon wire to keep vine protectors from being blown over during wind gusts. Catch wires should be installed prior to the second growing season.

Unloading Facilities

It is highly advisable to have the appropriate equipment ready when trellis materials are delivered and need to be unloaded. Unloading by hand is time-consuming and can be dangerous. Bundles of posts are extremely heavy and cumbersome. Try to make sure that your unloading equipment has forks; unloading with a front-end loader and bucket is feasible, but can be tricky and dangerous.

This list can be expanded to accommodate the needs of a larger vineyard, which may include a vine hedger, leaf remover and vine row cultivator. Not all of this equipment will be necessary during the vineyard development phase. Some can be rented or provided by a hired service.

Essential small tools

The vineyard will need plenty of hand and small tools as well, and many of them can be found in the garage. As always quality, durability and having the right tool for the job are essential. For example, it isn't possible to install a trellis or tighten a fence without a good come-along. A hardware store hoe will last five minutes working in rocky soil. It would be far better to have a machine shop weld together a slice of a disc onto a steel handle. The disk blade can be sharpened to a razor edge and will stand a full day of pounding against rocks. Other essential tools include a good hammer, fence hammer, pliers, pruning shears, pouches, etc.

All tools should be used only for their intended purpose and in accordance with the specifications for that job. If you do not obey this simple rule, somebody might get hurt or the tool may be damaged. Everyone working in the vineyard should make it a habit to return all tools to their proper place. Wasting time looking for tools can be a source of intense frustration.

Vendors

A lot of equipment, materials and supplies are needed to develop and maintain a vineyard. Vendors should become an important part of the vineyard infrastructure. Needless to say, it is important to develop relationships with good suppliers who sell quality materials at a reasonable price, who know their products, and who can service them in good time for you.

In many of the Eastern wine regions, a critical mass of vineyards has not yet been reached (Long Island, the Finger Lakes and the Niagara Peninsula are exceptions) that would

justify a robust support system for the wine industry such as California enjoys. Specialty suppliers to vineyards are few and far between, and you may have to drive a long way to find a suitable tractor or sprayer; hence a lot of supplies and materials will be ordered through the mail. This is one reason why production costs are higher in a developing wine region. Probably the best way to locate a reliable supplier is to ask another grower in the area. With chemical products such as pesticides and fertilizers, it is important that the vendor has the products you need and knows how they should be applied in vineyards. A knowledgeable vendor can be a valuable source of information, although growers should remember they are of course trying to sell you a product. Local growers and industry associations will be your best source of information regarding the vendors servicing your area.

Technical know-how

Vineyard development services are not widely available in the East, but one should be engaged if your level of skill and knowledge are not yet developed enough to do the job correctly and safely. Development companies have the experience, equipment and technology needed to install a vineyard properly. For example, Mudd Vineyards, Ltd. has installed over half of the vineyard acreage on Long Island and they do very high quality work. Stephen Mudd and his staff understand and know how to deal with local conditions and are tapped into the supply chain. Other companies may be available in other wine regions.

A vast array of technology is available to help the grower enter the age of precision viticulture. It is possible now to manage a vineyard literally vine by vine. This starts with vineyard site suitability systems that draw on vast digitized climate and soil databases to evaluate a site. Aerial and satellite imagery can be used for a variety of design and maintenance purposes, such as finding weak and low production areas in a vineyard. Overhead or side scanning systems programmed for Normalized Digital Vegetative Indexing (NDVI) can reveal just about every nuance in the canopy and assist with nutrient management decisions. Hand-held devices can help the grower to record and access vast amounts of data about his vineyard, including the GPS coordinates of every missing vine and spreadsheets with spray records and phenological data. Electroconductivity soil analysis systems make it possible to read the soil without even digging a hole. Climate monitoring stations are getting more sophisticated and less expensive every year. There are systems that will radio climate data to the computer in your house. There are even disease-modeling programs that can make recommendations based on the unique conditions of your farm, although cultivar susceptibility should always take precedence, especially if you have many different cultivars planted in one location. Soil moisture probes can guide irrigation decisions and leaf wetness monitors may help with disease forecasting.

Most of this technology is not yet practical or cost-effective for the scale of most Eastern vineyards. But as the industry grows and vineyards get larger, these gizmos and gadgets will become essential tools for the Eastern wine grower.

Chapter 18

Vineyard Management and Labor

The fun part of starting a vineyard is the process of education and discovery to create something new and unique, but then someone has to put ideas into action and create a working vineyard. The quality of the grapes will depend on the successful translation of information into results, which isn't always easy. Concepts can be complex and, as stated earlier, there's usually more than one way to do any task, interpret any data, or solve any problem. Labor issues are a challenge everywhere in agriculture. Skilled workers are hard to find. Language barriers exist. Misunderstandings abound. Employer-employee relations can be complicated and fraught with danger. But when a good team comes together to execute a sound viticultural plan, the results can be remarkably gratifying – both on the vine and in the bottle. Without exception fine wines are the result of good management and labor.

Small, one-person operations are usually quite straightforward and easy to manage. Lucie Morton estimates that one full-time person can take care of 4,000 to 5,000 vines, and that another full-timer should be added for each incremental increase of 4,000 vines. Assigning labor needs based on the number of vines rather than the number of acres makes sense, because it takes into account the variability in vine density in the vineyard. In the case of smaller vineyards that cannot afford to hire a full-time crew, pooling the available labor and getting a crew to work a number of vineyards is a viable option. It is important to keep workers employed all year round or they will leave when they are not needed and may not come back. It is possible for more than one vineyard to share a crew and still get all their tasks done in a timely fashion. Small vineyards in the East often rely on family and friends for help, but there are obvious disadvantages to this strategy. Often they will be good for a day or two but not more, especially if they find themselves working in the heat, rain or cold.

And the availability of family and friends should not be allowed to determine the date of harvest – the grapes make this decision.

There are work cycles in the vineyard that flow with the seasons. Pruning is often slow and steady. But even for pruning, there are different approaches. One is to hire a big contract crew to come in and do the job very quickly, but this often means sacrificing the quality of work due to the unfamiliarity of the crew with the vineyard. Alternatively, a smaller permanent crew that knows the vines can move at a steady pace through the winter months and prune at a very high quality level. Both will get the job done, but sometimes with different results.

Hiring a crew

Managing a vineyard begins with a passionate and knowledgeable owner who is capable of directing vineyard operations or of hiring a manager whom he can trust to oversee the work. Most vineyard owners underestimate the demands on their time and the amount of labor needed to operate a vineyard. Formulate a realistic estimate of your labor needs by talking to an experienced grape grower. Then let the foremen and field workers put your principles into practice in the vineyard. The quality of the grapes will depend largely on how smoothly this continuum of research, planning, practice and eventual rewards unfolds.

If the vineyard is small and you are the only pair of hands on the premises, the project will be a labor of love. As the vineyard grows, however, it will be necessary to hire additional help to keep up. This is when the owner-operator needs to take a long, hard look at how he can make the best use of agricultural labor.

Wine growing is a highly technical enterprise and complicated concepts must be understood, adapted to the unique features of a particular vineyard, and then translated into instructions that end up as work. Ask any successful commercial wine grower and he or she will tell you that one component, and perhaps THE most important component of fine wine is a good vineyard crew and equipment operators. Experienced, reliable, hardworking, observant, and creative – these are the qualities of a good crew and they have to be cultivated over time. Therefore, a serious vineyard owner knows that he must do everything possible to retain his best managers and workers! If consistency and uniformity of grapes is the hallmark of quality for a vineyard, then keeping the same skilled crew to do vital tasks such as pruning, canopy management and picking can only enhance the quality of the fruit. A high turnover rate will, as it does in most businesses, lead to a decrease in productivity and quality.

Farming used to play a large role in our nation's economy and culture but this is no longer true, and very few people today can say that they grew up on a farm. Hiring teenage kids is generally not a good idea. The best workers are often Latinos with farm experience. They have the right attitude and are used to the often physically demanding and repetitious work of the vineyard. There will be cultural differences to understand and take into account, but it is definitely worth investing time and effort to find the right people to tend the vineyard. They will be relied upon more than can be imagined and the value of intelligent collaboration cannot be measured in dollars.

Proper documentation is required for each member of the crew. They must always be treated fairly and with respect. Workers should be compensated at industry standards or better, based on their experience and the quality of their work. Having a crew that knows the vines and practices will make operating a vineyard much less stressful, and will result in quality, consistency, safety and other benefits for the vineyard. Over time the crew will learn what to do, and be able to do it without even being asked, so that the owner can spend more time on essential tasks away from the field.

This does not mean that the workers should not be monitored and evaluated. Even though many of the tasks are somewhat menial, the quality of their work will impact fruit quality. If a worker is not planting a vine at the proper depth or is not removing the right number of leaves from the correct nodes on the morning side of the vine, the grapes will suffer. Constant vigilance is necessary, especially during the training phase. And never assume that just because a crew is doing a good job at 9 a.m., they will be working to the same standard at 3 p.m. Ultimately, it is up to the manager and the owner to maintain quality standards by hiring the right people and working closely with them.

The crew: a genuine asset

A typical vineyard crew will include a foreman who can lead the team in their daily activities and who hopefully will speak English. At the next level will be the equipment operators, or else crew members whom you know can be trusted to drive a tractor, fill and mix a sprayer, or operate a post pounder responsibly. The field hands can be divided into groups based on their years of experience and the type of work they are doing, and should be paid accordingly.



The wine will only be as good as the skill of the vineyard crew

These are the people who will be in the field day in and day out, and who will develop an intimate connection with the vines. What they see, feel, smell, hear and taste in the vineyard matters to you as the manager or owner of the vineyard. They should be trained to scout for diseases, pests and other problems, and to tell you what they see in a timely manner and without hesitation. The more clearly they understand what is required, the more useful information they can gather and share. Sometimes cultural barriers will impede a worker from

telling his boss bad news, so crew members should be told that it is alright to report problems in the vineyard. The best leaders can become excellent practical viticulturists and will often have useful suggestions about how to improve vineyard practices, reduce costs and increase quality. They should be encouraged to share their ideas.

Language barriers and cultural differences form a part of multi-cultural workplaces. Knowing some conversational Spanish can be very helpful; indeed, Spanish is a core course in many vocational viticulture programs. If the owner or manager is not conversant in the language of the crew, then a translator will be necessary; this would ideally be the crew foreman.

Instructions need to be simple, clear and specific at all times. Every task must be demonstrated several times, with the instructions reinforced and monitored continually during the workday. Show the crew exactly how the hole should be dug and the vine planted or tied to the training stake. Leave no room for misinterpretation of the instructions.

Finding legal agricultural labor in the East is a challenge and one of the most significant problems faced by larger vineyards. There is no book or agency that can help you to find agricultural labor. Probably the best way to start is by asking other commercial vineyards where or how they secured their labor. Often workers will have relatives or friends who are looking for jobs. Labor contractors may be a source of workers, but great care must be taken in selecting a contractor. Try to get a direct referral from another vineyard to assure the quality of work and the treatment of workers by the contractor. Check your state's department of labor and the contractor's references to make certain that the contractor is properly licensed and bonded. Nurseries and farms growing other crops are possible sources of labor. During their down season you might be able to hire workers. The federal government also runs a seasonal migrant worker program called H2A that has been successfully used by some of the larger vineyards in the East. H2A prescribes the times, conditions, wages, housing and other requirements that must be met to give an employer access to legal migrant labor. This is the agricultural labor system used in Canada, where it works very well. In the U.S. it is becoming more popular during a time of heated political debate over immigration issues.

Vineyard Development: Labor and Cost Considerations

*Fernando Franco, Vineyard Manager
Barboursville Vineyard, Barboursville, Virginia*

The quality of the vineyard development (soil preparation) and planning (variety, clone, and trellis system selection) that you put in at the beginning is the key to the long-term success of your vineyard. The establishment phase is critical for any new winery or vineyard that aspires to produce high quality wines, because every bottle of wine is a reflection of the terroir climate conditions, and decisions made during the development phase (location, soils, rootstock, clones and varieties). I planted my vineyard for the long-term and with the view that the work put into its planning and development will be reflected in and will influence the wine quality for the next 30 years, if not more.

Agricultural labor is a difficult issue in every aspect of vineyard development and for viticulture in general. To plant my vineyard at Barboursville, I employed workers on an H2A visa program. For our 140 acres we now employ 13 H2A and 4 permanent workers who come from Mexico and El Salvador. Some of them have been working here for 9 years and have been trained and are supervised by me in every single area they are involved with, because it is crucial to explain to them the reasons for and the importance of every task that they do, from planting to harvest, and how their work will influence the quality of the wine. I firmly believe that a trained worker is my best asset.

All of our workers have been trained in worker protection standards (WPS) and their safety and well-being is of paramount importance to me. We have built new lodgings so they can have a nice place to live, and every year we have inspectors from the health and labor department come in to check that all the living standards required by law are met. The H2A program has its own salary structure and we follow what is called the AEW (adverse effect wage), which mandates that no one in the vineyard can earn anything less than the AEW, which for this year is \$9.05/hour. This tariff is adjusted annually.

We machine plant all our vineyards. It takes 5 people to run the operation, from the tractor driver to the 4 people who do the planting, and on a good day with good land preparation we can plant up to 6,000 vines/day in vineyards with 450 vines per row. I like to have the vines in the ground between late March and early April to take advantage of the spring rains and cool temperatures. The vineyard is dry farmed.

The next step is the trellis system, and tying and disbudding the vines to a single or double shoot, depending on their vigor. From this point on, all the decisions made in the beginning are in place: site selection, matching soil conditions with the variety and clones, planting and trellis.

The following cost breakdown per acre is based on numbers from last year; I hope that it may be of some help.

Cost of developing one acre of vineyard at 2.3 m x 1.10 m with 1,615 vines per acre on a VSP trellis system:

Labor \$4,500

Vines \$5,670

Trellis \$3,950

A deer fence should be installed and the cost of this will be determined by the size of the vineyard.

To monitor vigor control, and depending on the growing conditions, I like to have some grapes on the vines in the second year after planting. I usually harvest about 1 ton of grapes per acre, with about 80 - 90% production by the third year.

Hiring a vineyard manager

In the East, professional vineyard managers are even more scarce than good field workers. This is the person who will lift the daily burdens of management from the owner's shoulders, so he or she had better be the right person for the job. Most people who decide on a career in the wine industry choose to work in the Western states. It's the oddball who elects to work in the cold, humid and wet conditions of the East. However, as the industry grows and matures it will attract more and better managers and workers to our region.

A good vineyard manager should have excellent communication, problem solving, organizational and leadership skills, significant experience growing the style of wine that is your goal, and preferably some formal education in the biological sciences, including plant science and/or horticulture. The truth in our industry is that most vineyard managers have little formal viticulture education and are graduates of the School of Hard Knocks. Some of them may be outstanding and others barely competent. Fortunately, undergraduate viticulture programs at Cornell University and other land grant universities, along with vocational programs at community colleges such as Harrisburg Area Community College, are now feeding trained viticulturists into the industry. These graduates are not necessarily better than those from SOHK and they will often lack practical experience, but the best of them are fast learners with the potential to pick up the necessary management skills. Long Island and the Niagara Peninsula have the greatest concentration of outstanding vineyard managers in the East. Most will have come up through the ranks in the field, but Cornell University, Brock University and Niagara College are now graduating larger numbers of qualified vineyard managers.

Budgeting considerations

Labor will be the greatest expense in the annual operating budget and harvest will always be the most demanding period. In a high-quality vineyard where most of the work is done by hand, labor costs can reach 75% of the vineyard's total operating costs. You would be wise to plan realistically for the needs and budget carefully for the costs of skilled labor.

There will be other labor-intensive periods in the annual vineyard cycle. Considerable help will be required at the outset for planting. Afterwards, it is important to know what the labor-intensive tasks are and for when they must be scheduled. Pruning takes place during a quiet period, but you still need a highly skilled crew to trim the vines. Canopy and crop management can be very time-particular and labor-intensive tasks. The vine won't wait, so you must have the necessary crew on hand when they will be needed.

Labor regulations

The least romantic part of farming pertains to regulatory requirements and compliance. Agriculture is handled differently from most manufacturing industries. A thorough understanding of federal, state and local regulations and scrupulous compliance are needed. Almost all of these practices will fall under the umbrella of common sense. But common sense and the law are not always the same.

The current immigration regulations are political and bureaucratic flypaper and if your business has employees it is important to understand your responsibilities, because the compliance standards will increase significantly. The Internal Revenue Service, US Citizens and

Immigration Service (USCIS), Social Security Administration, Environmental Protection Agency, state and federal departments of labor, OSHA and other agencies will all be interested in what you are doing. The USCIS (formerly the Immigration and Naturalization Service or INS) has well-defined rules for the documentation of new employees. The IRS demands a W-4 form for each employee. The Department of Justice also requires employers to inform them of every new person hired.

Once they are hired, all agricultural employees must comply with EPA worker protection standards (WPS) and be offered adequate training. Pesticide education programs at the state's department of agriculture or the college of agricultural sciences at the land grant university will help farmers to stay in compliance. Detailed pesticide use records may be required by state agencies. If a labor contractor is engaged to provide field workers, this person should be licensed and bonded by the state's department of labor and must provide you with all the necessary documentation.

In cases of non-compliance, there is the risk of potentially significant liability and fines. Learn what the laws are and follow them to the letter. The compliance chapter in *Oregon Viticulture* provides a good overview of this complicated, but necessary part of the vineyard business. There are companies such as the Farm Employers Labor Service (FELS) that specialize in agricultural compliance issues.

Chapter 19

Post-Planting Vine Care

You have the vines in the ground and now you can breathe a sigh of relief. Or can you? The reality is that you will hardly have time to catch your breath – get used to it. Some absolutely critical attention and care is needed right now. A lot will depend on the weather and field conditions, but new vines are like newborns and will be vulnerable to a wide variety of ailments and threats. The challenges to a long and productive life are just beginning for the vine and it will be up to you to thwart each and every one.

In Year 1 the main concerns are protecting the foliage and feeding the roots. Potential problems include, but will certainly not be limited to:

- Fungal diseases, especially powdery mildew and downy mildew
- Insects, in particular Japanese beetles
- Leaf munchers, such as rabbits and deer
- Weed competition
- Nutrient deficiencies, most notably potassium and magnesium
- Water stress, often due to unexpected heat spikes or failure to remove grow tubes
- Trunk diseases and viruses

You will need to have strategies in place before the vines are planted to deal with each of these menaces and others that may pop up unexpectedly. This will be the first test of applied viticulture and you want to shoot for an A+.

First considerations

The first year is all about establishing a strong and healthy root system for the vines. This means encouraging plenty of foliage to feed the roots. Young vines are more susceptible to just about everything compared to older vines, such as disease, insects, weed competition, drought, mechanical damage, neglect, etc. Care in the first year, and especially right after planting, is important to get the vines off to a good start. Vines that are stressed early in life may never perform as well as healthy ones, so there are long-term benefits to early primary care.

As with every phase in the development of the vineyard, it is crucial to understand what you need to do, how to do it, and the tools that you will require. A prudent grower also knows what to expect. In other words: Be prepared. And preparation must begin well before the new vines are planted. A good deal of farming is purely reactive, but we must strive to be proactive in vineyard management, in that an ounce of prevention really is worth a pound of cure. Any need or problem that can be anticipated and headed off before a vine suffers will be good in the long run for quality.

If a newly planted vine does not break bud and seems determined not to be alive, pull it out and replace it with a new vine. Vine survival must be monitored closely throughout the season and replants dug in as needed. Losses at this time will usually be due to poor nursery materials. A 2% overage in a nursery material order is normal to cover the need for replants.



Newly planted vineyard on the North Fork of Long Island

Don't wait until next spring to replace "misses." If the number of replants needed exceeds 2% then a conversation with the nursery and a request for replacement vines may be warranted. A key long-range goal of every vineyard is to have vines of the same age within a vineyard or sections of a vineyard. Lack of age uniformity within sections may be detrimental to wine quality. However, if there is a large-scale failure in the new planting, then the vines, soils, methods and other possible problems must all be reviewed before any further planting is done.

Novice growers always hope to see an explosion of growth in the first year, with vines reaching the trellis wires and ready for training. This comes from our experience growing tomatoes in the garden – bigger must be better. However, more modest growth of new vines is to be preferred. All of the most important decisions, from site selection to the choice of plants, have led to this result and the payoff will come years later in the form of a balanced vine of modest size. A vine may grow enough to begin the training process with winter pruning, or it may have to be cut back to two buds to ensure a stronger root system, establishing itself on the trellis in the second growing season. Don't worry if a vine has not grown to the top of the trellis by mid-summer. In fact, a smaller vine may be a harbinger of quality later on.

Fertilizer should be added only if a properly interpreted soil or petiole test or visual symptoms indicate a treatable nutrient deficiency. New clones and rootstocks have demonstrated a tendency to display unusual leaf symptoms, particularly color, but new vines will often grow past these problems. Show restraint when treating what may or may not be a problem in new vineyards. The advice of an experienced grower can be helpful in this situation.

Scouting the vineyard should become routine; it must begin as soon as the first vines are planted and should last for the life of the vineyard. There will be no shortage of challenges to the successful establishment of healthy vines. New growers should familiarize themselves with the many threats that menace their vineyard. These are often divided into biotic and abiotic categories. Biotic problems for new vines are caused by disease, insects, and other critters like deer and rabbits. Abiotic threats include plant nutrition, chemically-induced problems (herbicides taken up by the vine or damage to foliage caused by improper spraying), tractor blight, etc. The list is a long one and the better you understand each threat, the more prepared you will be when it strikes. It is important that you detect problems early and react quickly. The experienced eye of a consultant or fellow grower may help significantly during this period just after the vines have been planted.

Water

While moderate stress may be desirable for mature vines to produce good grapes, all forms of stress should be avoided in newly planted vines. The vine establishment period is a particularly important time to avoid water stress, as it can severely hamper the growth of new vines. Indeed, in a drought year irrigation may be necessary. While the East often receives summer rains, there can be lengthy periods of dry weather. You should be prepared for this and

have water ready. Be familiar with the visible symptoms of water stress such as yellowing leaves, shortened tendrils with burnt tips, short internodes and a smallish, tight shoot tip. Instruments such as tensiometers, gypsum blocks, and the monitors included with climate data loggers can measure soil moisture and help predict the onset of water stress.

A vine will always appreciate a drink after the shock of planting. New vines will be highly susceptible to heat spikes, i.e. sharp increases in temperature. Water can be applied prior to a heat spike to keep new vines well hydrated. Water should be applied as soon as possible after visual symptoms of water stress are detected. In California new vines are typically watered with twice a week with three gallons of water in each set. However, if you are counting on using a drip system, some careful planning will be necessary to coordinate its installation. A drip system is often not fully installed until after the vines are planted. It should be rigged and tested as quickly as possible so that it will be available during the critical first weeks after planting. But you will need a trellis system to hang the drip hoses on. Here you may encounter scheduling problems because, while trellis can be installed in a hand-planted field prior to planting, in a machine-planted field it must be constructed afterwards. If drip irrigation is not available immediately after planting in the first year, be ready with a water delivery system for eventual dry spells.

Vine nutrition

As a general rule, if soil fertility tests indicate adequate nutrient levels and the vines show no symptoms of deficiency, then they can be left alone to grow through the first year without the addition of fertilizer. Later in the growing season, new vines may display symptoms of magnesium, potassium or (sometimes) boron deficiency, which will often be related to weather conditions and soil moisture. Usually these do not pose a serious threat to the vine. Some growers use a triple-8 or triple-16 fertilizer blend of nitrogen-phosphorus-potassium on new vines to help get them started, but more as insurance than out of any real need.

Depending on soil texture and drainage, the amount of actual nitrogen applied to new vines should range from 10-20 pounds of actual nitrogen per acre, but great care should be taken not to burn the roots and/or leaves with too much nitrogen. Excess nitrogen may also encourage excessive first-year growth; long internodes make training difficult and thick (bull) canes can be more susceptible to winter injury.

New growers sometimes think that unless their vine displays tremendous growth in the summer it is in need of something, but you should remember that the goal is modest growth and a moderate-sized vine. When a vine grows vigorously and reaches the fruit wire or beyond, it is reflecting the excessive potential of the soil. Any application of fertilizer to new vines must be done judiciously and carefully. If drip irrigation is in place, fertigation through the drip system is a good method. If applied by hand, fertilizer should be carefully measured and spread in a 6-12" radius around the trunk of each plant, and never directly at the base of a vine.

Trunk diseases (viruses, fungi, insects)

In this age of new clone and rootstock selections, young vines may display abnormal leaf symptoms whose exact cause is hard to determine. Viruses, and a host of other trunk diseases, have plagued the nursery materials used by Eastern vineyards. Young vine decline encompasses



Crown gall on a newly planted grapevine plant

a galaxy of vine maladies, including different trunk pathogenic fungi, winter injury, viruses, insects (such as the grape root borer) and other phenomenon that can severely affect the health of new and older vines. Latent pathogens, including the ubiquitous and dangerous crown gall (*Agrobacterium vitis*), often lie dormant in the vine's vascular tissue until a particular stress, such as winter injury or a mechanical stress, causes the disease to express itself. Leaf roll and Tomato Ringspot viruses are probably the biggest concern for Eastern wine growers. Syrah disorder, which affects the graft union, has become a significant problem in California recently and is now being seen in Eastern vineyards. Growers need to be aware of these problems and must remain vigilant after planting. Most of all, they should strive to purchase clean and healthy plant materials.

Using certified vine materials will reduce, but not eliminate the risk of these problems in the vineyard. Vague symptoms in new vines should not necessarily be cause for alarm as they may disappear over time. Growers should learn about more serious threats, such as leafroll virus, and have consultants and testing procedures ready to identify and react to any problems as quickly as possible. Colored tape is a simple but practical tool that can be used to mark vines for follow-up visits or inspection, and growers should always carry a roll in their pocket. Any vines that do not appear normal can be flagged and noted, and then monitored throughout the growing season. These flags should remain attached for possible spring replanting.

Integrated disease and pest management

Lots of living things like to eat vines, from organisms you can barely see to big ones with four legs. Disease, insect, and pest control measures all need to be in place before the vines are planted. If you consider what rabbits, deer and other vertebrate animals can do to the leaves on a freshly planted vine, then you will understand why a deer fence and grow tubes, which offer some protection from browsing animals, may be well worth the investment.

One of the key insect pests for new vines is the Japanese beetle. These usually appear in early to mid-July and their feeding can significantly reduce the leaf area. Be ready with a strategy to do battle with these copper-colored foes. Insecticides are an effective tool, but must be used correctly and safely. Follow the instructions on the label, and do not overuse any product. Pesticides should be targeted directly at the pest or at the vine parts that require protection or treatment. Target organisms are capable of developing resistance to fungicide and insecticide materials that will render the product ineffective over time. It is therefore important to rotate between different active ingredients in order to avoid or delay the onset of resistance, and only apply pesticides when they are needed.

It is strongly recommended that as a grower you get a pesticide applicator's license. State departments of agriculture have programs for commercial and private applicators (users of pesticides). Some of the more toxic materials are restricted and can only be purchased and applied by licensed applicators. It is necessary to pass an exam to obtain a pesticide license and this must be updated with continuing education, often obtainable through cooperative extension

courses. The study book will train the user regarding pesticide safety, use and handling – all very important information to any vineyard operator. Fortunately, vineyards do not use many restricted materials (insecticides and some herbicides), but it is still a good idea to pass the exam and maintain proper pesticide credits.

This will be your first opportunity to practice integrated pest management (IPM). To be successful, you must anticipate the threats posed and the damage that may be done. Learn how to scout the vineyard, making use of the excellent visual aids available on the Internet and in extension fact sheets to help you recognize diseases and pests. Get to know your extension educators, and specialists in plant pathology, entomology and other areas of concern. Become acquainted with the most common fungal diseases, especially powdery mildew and downy mildew, which can damage leaves or cause them to drop from the vines. New vines should be sprayed with the proper materials on a regular basis following recommendations from a reliable source. Losing leaves prematurely to mildew or insects will compromise a new vine's health and cold hardiness during the winter.

Applying pesticides to new vines can be done using commercial sprayers or backpack sprayers depending on the size of the vineyard. Grow tubes may hamper effective coverage of leaves and should be removed prior to application. Application rates are harder to determine for a backpack sprayer, but correct calibration for all pesticides is necessary to avoid inflicting damage on vines as well as the environment.

In the case of pesticides and fertilizers, the notion that “more is better” rarely applies and can do more harm than good. It is absolutely vital that farmers follow the recommendations on the label for all chemical products, regarding safety, handling, mixing and application instructions. You should supplement this knowledge with information gathered from viticulture, plant pathology, entomology, and other extension and science-based resources, as well as from vendors, publications and fellow growers. You should understand what a pesticide is designed for, how it works, and how to use it properly and safely. A tremendous amount of development and testing work is done with each product before it finds its way to the market, but the margin of error between proper and improper use may be quite small. When in doubt, do research and ask.

There are excellent information resources available on the Internet. For pesticides, the *New York and Pennsylvania Pest Management Guidelines for Grapes* is updated each spring and should serve as the basis for an effective and sustainable integrated pest management program. Many state extension services publish a grape disease and pest management guide for their growers.

Remember that proper scouting is the key to the control of all diseases and pests. Knowledge of the foe will enhance the grower's ability to defeat it with minimal impact on the vines, fruit quality, and the environment.

Weed control

This topic has already been discussed, but its importance cannot be sufficiently emphasized. In a warm, humid and rainy summer climate, weeds can thrive and quickly take over a vineyard. There is probably no greater single problem in Year 1 viticulture than weeds that get out of control and compete with new vines for water, sunlight and nutrients. This competition, especially in a dry year, can hamper development – especially of the roots – and

prevent the vine from growing to its full potential. It will slow down root development and may, at worst, affect a vine's health and productivity up to the entire life of the vine. In the short term weeds can delay the vineyard from achieving its first full crop, which would represent a serious economic setback.

Well before planting, a specific and realistic plan of attack (based on the amount of weeds present and efforts to control them prior to planting) should be prepared to deal with the problem after the vines are in the ground. Get the necessary manpower and equipment (from hand hoes to mechanical grape hoes, herbicides and sprayers) ready before the vines are planted.

Just because a field has been cultivated and looks to be free of weeds does not mean they will not reappear. Weed control is almost always more work, in terms of time, manpower and equipment, than new growers anticipate. If you are using a mechanical cultivator, make sure that vines are aligned to the center of their row and that new shoots are protected from the blade and sensor arm by either a grow tube or a steel training stake. It would be a good idea to do a little practicing with the grape hoe if you are a novice to gain experience and become comfortable operating it.

Talk to growers who have weed-free vineyards and find out how they gained control. While no grower likes using herbicides, they will probably be needed in new vineyard development, both before and after the vines are planted. An approach that combines the application of chemicals and mechanical tillage works well in our region. Select the proper equipment – you will need a dedicated herbicide sprayer with the right sized pump and nozzles and the correct tillage implement. Weed Badgers are too large and cumbersome for our small vineyards and do not work well in rock and on sidehills. Grape hoes made by Braun, Clemens or Rienieri are the most common. The nature of the soil and topography will of course impact the effectiveness of any mechanical tillage implement. Give this problem careful consideration and consult other growers for the best methods and equipment.



Weeds in new vineyards can adversely affect vine health and vineyard profitability

Hand hoeing is very effective but strenuous and not practical for large vineyards. If weeds are out of control, it takes a lot of labor to fix the problem. It may be necessary to follow up mechanical hoeing with a hand pass near the base of the vine. A stout and sharp hoe will make the job easier and faster.

You will have to learn about the different herbicides available – including pre-emergence and post-emergence and contact vs. systemic herbicides – and their proper application. There are even specific herbicides and legal application rates for new vineyards (defined as less than three years old). Mechanical and chemical weed control can be a definite challenge with both tender, low shoots and weeds growing in the same area. Like weeds, vines are plants and will be susceptible to damage from herbicides. Great care should be taken in applying herbicides to young vines, because the leaves can be damaged and the shallow roots will take up any chemicals that are added to the soil. Herbicide should be applied near and around vines using a

shielded backpack sprayer at very low pressure. The *New York and Pennsylvania Pest Management Guidelines for Grapes* has a very good section on vineyard weed control.

A new philosophy is taking root in vineyards as growers begin to farm more sustainably. Nuking every weed is no longer considered strictly necessary. In fact, the very concept of “weed” is being replaced in at least some growers’ minds by that of “biodiversity.” An absolutely weed-free, pristine vineyard is no long the gold standard. Some “other” plants are now acceptable in this new visual aesthetic of what a well-managed vineyard should look like. Grapes are generally grown in monoculture, which in the midst of complex ecologies can lead to problems with disease, insects and other plant pathogens. Floor management practices may help to increase bio-diversity on the farm and enhance, for example, the presence of beneficial insects. There is an excellent vineyard floor management guide available from DCNR in California (see information resources list).

Cover crops

Weed control should form part of a broader vineyard floor management strategy that includes the use of cover crops, soil management, erosion control and other measures. Some growers plant a cover crop after the field has been cleared and before the vines have been planted, either an annual grass or an orchard/vineyard blend of annual and permanent grasses. Others clean cultivate with a disc or harrow so that vegetation will not compete with the new vines. In the Eastern U.S. frequent summer rains can cause erosion and limit access to a clean tilled vineyard, and under these conditions cover crops in Year 1, if established in time, can be beneficial, especially if irrigation is available to assist the vines in the event of a drought period. In late September or October before or after vines are planted a cover crop, often an annual grass, can be established to hold the soil through the winter.



Wild flowers as part of a cover crop mix at Black Ankle Vineyard in Maryland

One word of caution: in new vineyards care must be taken that the cover crop does not out-compete young vines for water and nutrients, especially if a dry summer follows planting. If drip irrigation is available, a cover crop can be installed in the spring, but it is more likely that the vineyard will have to wait for a fall cover crop.

Eventually a permanent cover crop can be installed. If irrigation is available, a cover crop can be installed right away. If the new vines are dry farmed, a cover crop is usually planted in the second or third year (a winter cover is used to hold the soil). These are often low, slow-growing grasses, such as fine fescues, which have a dense root mass that can choke out broadleaf weeds and do not have to be mowed quite as often as a bluegrass or ryegrass. Covers should be carefully selected for their performance characteristics and viticultural benefits such as vigor reduction, erosion control or green manure. Recent research in Virginia and North Carolina has

demonstrated the remarkable ability of cover crops to influence vine vigor. Cover crops also reduce soil compaction and help with air and water penetration into the soil.

For the best results, cover crops should be planted using a seed drill of correct width applied to a proper seed bed at the right time of year. The advice of experienced fellow growers and seed vendors is always helpful. Apply the maximum recommended rate of seed for good establishment. The secret is to seed very heavily with an annual orchard/vineyard grass like rye that will establish quickly, and a perennial such as creeping red fescue that will fill in over time.

Mulching

Live grass or cover crop in the vine row directly under the vines is not recommended since, even if mowed, the crop will compete too strongly for water and nutrients with the young vines. Mulching vines is not a common practice in the East, but is known to be effective in suppressing weeds, preserving soil moisture and, when the vines are more mature, potentially hastening ripening and reducing the incidence of disease. There are many types of mulch that can be applied to the vine row. Plastic is then laid with a special device, usually directly over the vines (holes are cut during the process). The plastic will work well for 2 to 3 years and then fall apart, after which it must be disposed of in a landfill. This technique is very effective in checking weed growth.

Synthetic and organic mulches are often used in mature vineyards as a way of controlling weeds and pushing grape maturity, but mixed results have been reported and it can be expensive. If not correctly prepared, organic mulches or compost may introduce weed seeds into the vineyard and attract rodents such as mice and voles that can girdle young vines. Organic mulches will also have an effect on soil nutrients, a factor that should be carefully considered. Depending on its composition and amounts, mulch may boost vine vigor beyond desirable levels. It can also impact soil nutrients such as potassium and magnesium. Recent trials with shredded paper products have shown some good results in reducing vine vigor and diseases.

Grow tubes



Grow tubes on newly planted vines

Grow tubes involve some extra work but are extremely beneficial, first and foremost because they protect leaf tissue from herbicides. However, they must be installed correctly, with the base buried in the soil, or else a “chimney effect” could be created, causing herbicides to be sucked into the tube when they are applied. The warmer, humid, CO₂-rich environment inside the tube encourages the vine to grow more rapidly, although once the tip emerges the growth rate will be same as that of vines not growing in tubes. The tube also assists the training process by guiding the vine straight upwards, and will keep rabbits and other small animals away from new shoots.

Growth tubes do have some disadvantages. They promote shoots with long internodes that may not harden off properly before the winter chill arrives; they add to the difficulty of applying spray materials; and there are extra costs involved in the material and labor needed to install and remove them. Long internodes can make proper vine training more difficult. Vines in tubes are also more susceptible to heat spikes and the leaves can burn, especially if sulfur has been applied recently. In fact, if extreme heat is forecasted the tubes should be lifted out of the soil to allow air to enter the base of the tube and circulate around the leaf tissue within the tube.

Long internodes and “bull” canes should be avoided in early vine training. Bull canes often harden off late and are at increased risk of winter injury, which will interfere with the training process and overall schedule. The tubes need to be removed from all vines by early September. Prior to their removal, in mid-August the tubes should be lifted above the soil just a few inches to allow the leaves and shoot to acclimate to summer temperatures. Complete removal without acclimation can result in vine shock and some premature leaf drop. Removing the tubes by mid-September at the latest should allow the new vines to mature for the winter. This is a critical step in the development of a new vineyard and should not be delayed. An alternative to grow tubes are containers such as milk cartons, which do not come up as high as tubes and therefore will not force the vines to grow as much. The resulting shorter internodes may be better for early training, and the cartons offer some protection from herbicides and rabbits.

Soil treatment

Post-planting soil treatment can be important. The soil gets very beat up during the development process with so many tractor passes over the field. The top few centimeters of soil become severely pulverized and can form a hard, impenetrable layer over the surface of the vineyard. A compost dressing on the soil surface will help to restore the soil structure.

Vine structure and training

The vines are in the ground and the quest to achieve balance, uniformity, synchronicity and harmony must now begin. You have done the best to interpret the site and determine what to expect, but now the vines will reveal their own truth. The reality of the terroir will expose itself gradually; it cannot happen overnight. Hopefully all of the decisions regarding variety, clone, rootstock, spacing, trellis, etc. will prove themselves to be correct.

The main goal of early vine training is to provide as much leaf area as possible to develop a strong and healthy root system, but some degree of uncertainty about how to train the young vines in their first year of growth will be inevitable. The decision depends in part on the relative vigor of the vine, which will be determined by soil capacity and other environmental conditions. Assuming that water and nutrients are in adequate supply, it may be possible to establish the rudiments of a permanent vine structure as early as the first year. Growth, however, can vary greatly depending on conditions around a vine or within areas of a field. Most growers feel happy and confident when they see an explosion of growth in the first year. In truth this may not be the most desirable result. It could indicate a high capacity soil that will cause problems with vine vigor for years to come.

Even at this early stage of vine establishment, working towards a balance between soil capacity, the vigor of the vine (and its rootstock), and growing conditions this summer should be

the goal. According to the French, a vine that has been trained in its youth to be small to medium in size is much more likely to retain those size and balance characteristics. Therefore, you are looking for restrained growth in a healthy vine, with 4-6 shoots, moderately spaced internodes and a modest shoot diameter. Training for proper internode length is especially important for vines that will be cordon-trained and spur pruned.

If a new vine is pruned to one shoot, that single shoot will probably be very vigorous and may not offer the best wood for overwintering or training in the second year. Also, a new vine with a single shoot is much more at risk from deer, rabbits, herbicides, wind and other threats that may damage the shoot and, with no other shoot available to replace it, the training process will be set back a year. On sites with lower vine vigor, the traditional “bush” method of simply letting all the shoots grow will help the root system to develop.

In their eagerness to see their first crop and an economic return on their investment, growers may be tempted to push the vine to establish its form in the first year, but this is almost always a mistake. Stressing a vine in its youth may negatively affect its long-term health and cause the expression of latent viruses such as crown gall and Petri disease. The primary goal in Year 1 is to develop the vine’s root system, which will be young and immature coming out of the nursery, and to establish a firm connection between the roots and their new environment.

A trellis system should be installed for proper vine training. The timing of this can be tricky, especially if laser or machine planting is done and the field must be open. Shortly after planting, the trellis must be installed with at least the fruiting wire (and drip irrigation wire, if needed). Training stakes can then be put in place and the shoots gently trained up them using either tying tape or grow tubes. It is important to keep the vines from sprawling over the ground, where they could be run over by tractor tires, are more susceptible to disease, and cannot be easily sprayed. To make sure that the vines can expand and grow, use good quality, flexible training tape, not stiff ag ties or twist-ties.

If growth is modest, 4 to 6 shoots can be retained and loosely tied to the stake. This will be your one and only chance to get a straight trunk. The reasons for wanting a straight trunk are innumerable and yet many growers fail in this critical task. As more and more vineyard operations and tools are mechanized, from grape hoes to harvesters, a straight trunk is vital for optimal equipment performance. Plus – it just looks a lot better.

The question of how many trunks to train on a new vine is one every grower needs to ask and, like so many viticulture decisions in the East, the answer will depend on an assessment of the risks of the climate and the tolerance of the vine. The trunk number will generally be decided on the basis of the risks and potential severity of winter injury. In Virginia and points south, growers often leave only one trunk. Around the Finger Lakes and Ontario, two trunks are normal. Winter injury is a surprisingly random phenomenon and it is impossible to predict whether one or both trunks might be damaged or lost. By practicing ‘spare parts viticulture’ and leaving multiple trunks, we are attempting to reduce the risk of a completely open space in the canopy. Multiple trunks have greater management requirements (e.g. training, suckers, etc.), offer more surface area for potential overwintering disease organisms, and are not as neat in appearance as single trunks, but there can be no doubt about the advantages they offer when it comes to winter injury.

Try to avoid the syndrome known as the “home vineyard” effect. It is understandable that the block of vines closest to the owner’s home or the winery entrance will be particularly

well cared for since it will help to form a visitor's first impressions. As vines get further from the main gate they tend to show more signs of neglect. Every effort should be made to farm a vineyard uniformly over its entire area so that distant blocks do not become the neglected stepchildren of the property.

Preparing for winter

Preparing a vine for winter in cold regions begins during the growing season. In most cases you should remove all fruit clusters during the summer of the first year. It is not necessary to remove the jklaterals. By the end of August shoots should be "hardening off" or lignifying into woody tissue. If they are not, then the vine is growing too vigorously and may not mature properly before the first deep freeze event. This could lead to tissue injury. Encourage vines to harden off by withholding or limiting water and applying no nutrients later in the season.



Taking down the berm in spring requires a skilled tractor operator

task effectively. If you do not have the weed problem under control, it will be even more difficult. Textbooks do not explain how to hill up and take down in spring, so the best way is to learn from an experienced grower. The job is decidedly more challenging on hilly terrain (especially side hills) and in rocky soils. You must decide for yourself whether it will be worth the time and expense given the climate conditions. Once again, risk tolerance must be factored into the equation. You should consider the cost of grafted vines, the labor to replant and the loss of uniformity in the vineyard in making the decision.

Protecting the graft unions of young vines in cold regions is important. In a practice called "hilling up", the lower part of the vines is buried under soil to provide insulation against the cold. Then, even if a severe freeze occurs, the scion may not be completely killed and suckers can be used to retrain the vine. This is not a great scenario, of course, but it is one that growers in cold region must accept. Hilling up requires a skilled operator using a special tool to push a mound of soil over the base of each vine. It is time-consuming and the soil must be in the right condition, usually after harvest and before the first hard freeze, to complete the

A winter or permanent cover crop should be seeded in the late summer or early fall to make sure that it gets established before winter sets in. The vines should be pruned as late in the winter as possible, but must be fully pruned before bud break in spring. Select the two healthiest canes as the trunks for two unilateral canes or cordons. In cold regions spare parts – either an addition cane or spur – may be left in a lower position as a renewal unit if needed. If the cane diameters at the fruiting wire are not 3/8" (pencil thickness) or greater, they should be pruned back to 2-3 buds. With the root system established, these buds will offer more vigorous shoots in Year 2 for training purposes. If lengthy shoots grew in Year 1, these can be pruned to begin the establishment of the vine structure.

Temperature and wood and bud viability should be monitored during the winter. If a winter injury event occurs, the buds and wood should be tested for viability and adjusted accordingly by pruning. *Winter Injury and Methods of Protection* is an excellent resource for cold region viticulturists (see the Information Resources list).

Typical New Grower and Year One Mistakes

1. Not doing all the necessary homework (research, organizing, site evaluation, etc.) in preparation for planting
2. Not getting the right equipment and tools for the job or misusing them
3. Not having enough skilled labor available to do the job right and on time
4. Letting weeds get out of control
5. Letting disease get out of control
6. Letting Japanese beetles get out of control
7. Improper use of chemicals, including fungicides, insecticides and herbicides
8. Letting deer, rabbits and other animals summer prune young vines to the nub
9. Applying too much or too little fertilizer
10. Not preparing the field properly for planting
11. Improper planting techniques
12. Not using proper training materials and methods

This list is only the tip of the iceberg. Each one of these mistakes could reduce the quality and sustainability of the vineyard. Plan down to the smallest detail then execute conscientiously.

Chapter 20

A Few Words about Sustainable, Organic and Biodynamic Wine Growing

We live in a buzzword- and fad-driven society and many who aspire to own a vineyard may be influenced by the popular media, which tends to romanticize wine growing and to distort the facts in the process of reporting them. Wine production is mostly NOT about what you read in the pages of the *Wine Spectator* or *The Wine Advocate*. While it is far from the job of this manual to tell people what to believe, we would like to underline that it is the responsibility of every wine grower to produce high-quality wine that will benefit the wider wine industry as well as his or her own vineyard, and to do it in the most sustainable way possible. Assuming that as a new grower you can immediately adopt organic or biodynamic practices may be dangerous to the health of your new vines and the quality of the wines.

You should study what sustainable agriculture systems and practices are out there and how you might incorporate them into your vineyard operations. A planet that is under increasing environmental duress needs less intrusive agriculture. When America was an agrarian society, sustainability was inherent in the country's way of life, but in an age of petrochemicals we are offered more choices with greater benefits but also higher costs. As a novice grower you may think that one of your choices is not to use pesticides. The truth is that a grape grown using 'organic methods' does not necessarily mean a grape that was grown without pesticides, nor does it automatically make a better wine, nor can you assume that it is more environmentally friendly. There was a (very) novice grower on Long Island who proudly delivered some Chardonnay covered with powdery mildew to a winery, convinced that his grapes were special just because they had been grown organically. Of course there was no hope of making good wine from his diseased fruit.

Frankly, there are better ways to save the environment than growing wine. However, like most activities, growing wine is not an "either-or" proposition. If blending is an important technique for making fine wine in the cellar, the practice of compromise extends to the vineyard as well. A dogmatic attitude against the use of synthetic pesticides, herbicides and so on will severely limit your options and lessen the chances of a successful vintage. The truth is that you are trying to grow wine in a high-risk context dictated by less than favorable growing conditions. There is much less uncertainty in the arid climates of Chile and California and therefore low input practices are more likely to succeed there.

Organic and biodynamic methods of wine growing are not systems-based; instead they rely on empirical skills and experience and try to use materials that will have the least possible impact on the ecosystem. It takes an intimate knowledge of your vineyard, as well as great intuition, skill and experience, to grow wine organically, particularly in the challenging continental climate of the East. If you stop to consider who is successfully farming with biodynamic methods in Burgundy, Alsace, Austria or the Rhone Valley (wine areas with conditions similar to the East), generally the greatest names in wine like Zind-Humbrecht and Leflaive are mentioned. The truth is, they would probably make the best wines no matter what system of viticulture they used. Maybe you will be the same league as these folks someday, but you have to pay your dues to get there. Not every grower can attain their level of skill and competence, which would give them a chance to succeed using alternative practices. The beginner should begin farming with conventional methods fully integrated into a sustainable

philosophy, with the goal of producing the best quality grapes given the conditions of the vintage. As you gain more experience and intuition about your site and vineyard, you can use more sustainable or even organic practices and materials. In many cases, simply doing a better job of calibrating your sprayer, using a tracked vehicle instead of wheels, or timing your sprays better to reduce your applications from ten to eight may have greater benefits in terms of the environment than other more visible and more dramatic methods.

There is no question of course that every grape grower should try to farm as sustainably as possible given the conditions in his or her region. There are some excellent information resources that can help you to reach this goal. Two of the best are the *New York Guide to Sustainable Viticulture* and the *Lodi Rules: Sustainable Wine Growing* workbook. Every grape grower should strive to satisfy the requirements of sustainable viticulture in his or her region. Keep in mind though that it is pointless to be overly dogmatic in winemaking, as in any other endeavor. If you choose to introduce organic practices, do so for the right reasons and make certain that you acquire the necessary know-how first. Always study all of your options and make the best choice for your site, abilities and goals. Never forget that your goal is to make the best wine possible.

The *2010 Production Guide for Organic Grapes* from Cornell Cooperative Extension is an excellent current source of information for grape growers. While the recommendations are designed for native grape production, they can be carefully applied to hybrid and *vinifera* wine grape production. Black rot is still the Achilles Heel of organic *vinifera* wine grape production. Until this disease can be solved in commercial vineyards, the widespread adoption of organic practices will be difficult. However, in dry years, like 2007 and 2010, practices can shift towards more sustainable, even organic for the best wine growers.

Chapter 21

Continuing Education: Becoming a Lifelong Learner

If you survive your first year, you can begin to feel confident about your ability to run a vineyard. It will be helpful nevertheless to get an impartial assessment of the quality of the vineyard so that you know what was done well and what could be improved. Your knowledge gap is closing, but there is still probably a sizeable chasm. Here is where your consultant may continue to play a valuable role, heading into Year Two. Ask yourself whether you are actually capable of developing a sound integrated pest management program on your own, do you know how to calibrate a sprayer, can you properly train a vine, do you have a plan for vineyard floor management and irrigation, can you create a nutrient management plan, etc.? If you don't know how to do any one of these things, then you need to learn. This is the lifelong learning side to the wine business. The winter after planting is a good time to stop, assess what you have done, and determine what you still need to do and learn.

Many new grape growers do not have agricultural backgrounds and are not aware of their local cooperative extension service. It is part the National Institute for Food and Agriculture within the U.S. Department of Agriculture and has met the needs of agriculture and communities across the nation since 1888. Cooperative extension is usually attached to the college of agricultural sciences of a state's land grant university. It provides an interface between the academic expertise and research facilities of the college and the community and industries which it is its mission to help.

Extension educators (formerly called agents) divide their time between the field and the lab. If a grower has a problem in the vineyard, a viticulture or horticulture educator is often the first to respond to a call for help. If the educator does not know the answer, then he or she may take the question to a specialist in, for example, plant pathology or entomology (insects). If the problem is more complex, such as the recent arrival of late season rot organisms in vineyards, a research project can be set up to find the explanation or solution. The Cooperative Extension system represents an invaluable resource for agriculture.



Beginner grape grower workshop in Lancaster, PA taught by extension educators from PA, VA, MD and TX.

However, extension educators are not consultants and growers should be sure to distinguish between the two professions. Educators can make field visits but their primary role is to serve the larger grape-growing community by offering workshops, field days and other programs designed to advance the knowledge of grape growers. The winter calendar between January and April is particularly full, with extension and industry meetings that provide valuable opportunities to learn, network and visit new growing areas. Identify the events that best meet your needs and try to attend as many as possible. New growers should get to know the viticulture extension and research

resources in their area, and use and support their services.

As already noted, professional vineyard consultants can be extremely helpful in all phases of vineyard development and maintenance, and they often work in cooperation with extension educators. Some consultants specialize in areas such as disease control, soils or vine nutrition. As a vineyard matures, it is always a good idea to have someone new come in to provide an objective evaluation of your vines and practices. A vineyard is not a static system, and viticulture as a discipline is always moving forward, so getting another perspective will always add to wine quality.

It also bears repeating that industry associations and fellow grape growers can be great sources of information. Remember that the most valuable experience is local experience, and a neighboring grower will very likely understand the situation in your vineyard immediately. Industry associations exist to provide information and education for members and they should be enthusiastically supported. They also do the tedious but necessary work of advocacy for the wine industry in the state capitol, departments of agriculture, tourism and others, the governor's office, land grant universities and all the other partners who are critical to the growth and success of the wine industry. Remember that your vineyard does not exist in a vacuum. You form part of a larger community of wine growers and you should actively participate in its initiatives. If you are not doing your share, then someone else is doing it for you. Attend industry association meetings and pay your dues. Find out how you can help.

It is not absolutely necessary to understand and appreciate wine to be a good wine grower, but it certainly helps. The term 'wine grower' denotes a specific and highly qualified profession. The better you understand the end product, the better connected you will be to the continuum from the grape to the glass. There is truth in more than one sense to the motto: *In vino veritas*. The bottle provides a window onto everything that happened to the wine before it was uncorked, from the vineyard to the cellar. When you taste, taste not only for enjoyment but also to learn. Try to find a group that includes palates from both the production and the retail sides, as they tend to taste wines quite differently. Taste with wine makers in their cellars, particularly with those who use your grapes. Taste critically and in the company of people who are more knowledgeable than yourself about wine.

Remember that there is also a vast amount of information available on every topic connected with wine making in books, journals, trade magazines and on the internet. See the information resources list for some recommended viticulture educational resources.

Viticultural knowledge is constantly growing and evolving. The best wine growers keep up to date on the latest ideas and technologies, always on the lookout for what may work in the vineyard to improve fruit and wine quality.

Chapter 22

The Good Grower

What defines a good wine grower? There are certain qualities that can be found in the best growers from Pennsylvania to Chile and from South Australia to France. In Europe viticulture is highly empirical, based on generations of experience and tested each day in the vineyard and cellar. Growers at the best vineyards are highly intuitive in their practices, knowing by sight, sounds, touch, and smell what to do or what will happen in the vineyard. Lucie Morton can teach about balanced pruning and reel off the numbers, but in the field she prefers to look at each individual vine and prune it based on her sense of its needs and to obtain the correct size, shape and balance. This skill can only be developed over the course of many years. Sherlock Holmes rebuked his friend Watson once, saying, “You see but you do not observe.” This all too often true of wine growers as well, but you should strive to do better. What do you observe when you are in the vineyard? What does it tell you about the condition of the vine? Jim Law has often reminded me that we should be asking ‘why’ and not just doing things by the book or calendar: Why is this happening? Why am I doing that (e.g., putting on fertilizer, spraying a particular chemical, ripping the soil, etc.)? Asking why requires you to observe and think before taking effective and meaningful action. Keeping an open mind and not being subject to dogma, whether the most ingrained tradition or the latest viticultural fad, allows the grower to examine all of the possibilities and make the best choices for the vineyard. “Truth but verify” connects the vineyard system and agriculture to science, which attempts to explain what we observe or guide us in our practices. But science will never explain every phenomenon in the vineyard. The willingness to experiment, try something new, test an idea and push the quality envelope on any vineyard site will often reap a reward of understanding or even new knowledge. The best growers are naturally curious. They know how to balance science and technology with their own sense of how to create a vineyard ecology that is harmony.

Here are a few examples of good growers. What makes them so successful?



Jan Waltz of Waltz Vineyard, Manheim, PA



Brad Knapp at Pinnacle Ridge Vineyard in Kutztown, PA



Rutger de Vink (RdV), Jeff Newton (CVCA) and Jim Law (Linden)



Eric Miller and Brett Mihalsik from Chaddsford Winery



Joanne Levengood at Manatawny Creek balance pruning vines



Carl Helrich at Allegro Vineyards



Tony Vietri at Va La Vineyards



John Santos, Hazlitt 1852 on Seneca Lake



Lucie Morton and Nelson Stewart at Karamoor Farm Vineyard



Ed Boyce and Jean-Philippe Roby at Black Ankle Vineyard in Maryland

The best wine growers are constantly trying to learn more, and they understand that their commitment to the vineyard is for the long-term. They know their limitations but are always pushing forward to see what is possible. The process of observing and then adapting to changing conditions, whether in the vineyard or the market, is a never-ending one. Great wine growers are a truly unique breed, combining the qualities of the scientist, the engineer, the botanist, the businessman, and the dreamer. But above all they are outstanding farmers, and proud of it. Knowing that they must always strive to do better, they are patient, creative, passionate and endlessly curious. They are glad to share ideas and help others. Jan Waltz noted that learning is a process where you have to “Listen, learn, observe, test and implement.” This entails borrowing good ideas from different sources, distilling them to their useful components, choosing some for testing, and then adopting those that are most suited to your vineyard. The moment you stop doing this, quality ceases to improve. If you believe that you have reached the pinnacle, someone will soon be surpassing you.

The best growers have a deep and abiding appreciation and understanding of wine, its history, evolution, and quality. You should constantly and critically taste wines to gain an understanding of benchmarks in the wine world. You should evaluate wines with people who have a more skilled palate than yours; this is the best way to learn. Taste wines made from your own grapes, but also your neighbors’ wines, and regional, domestic and international wines that will improve your palate and give you a clearer vision of the viticulture and wine making needed to achieve benchmark quality.

The good grower enjoys being part of many communities and expresses this by being an exemplary steward of the land and sharing the fruits of his labor. There is nothing more heart-warming than the camaraderie that exists in the wine industry. You, as a wine grower, can go to any corner of the globe where wine is made and find kindred souls eager to welcome you into their midst, places where – as at home – it’s all about good food, good company, and a passion for making great wine. That is why I have been in this business for almost 30 years.

There is no formula for growing great wine. Your site will have its own ingredients and methods. There are important principles and practices that act as beacons along the path but it is up to the good grower to discern the fine detail that will lead to a great wine.

Good luck and remember that what you are doing is for the joy of making and enjoying fine wine!

Chapter 23

In Vino Veritas: Some Thoughts Concerning the Winery

It is really true: the truth is in the wine. The wine can tell the discerning and knowledgeable taster what actually happened to it in the vineyard and the cellar. We have tried to explain the importance of the vineyard. Now for a few thoughts about the winery...

All of your efforts will be for naught if you hand your perfect grapes over to a poor winemaker. This is the other side of the fine wine equation and deserves your attention. Even though it will be two or three years before you produce enough fruit to make meaningful quantities of wine, it isn't too soon to start thinking about the destination of your fruit once it comes off the vine.

In cool to cold viticultural regions wine making, like grape growing, is more demanding because there are simply more challenges such as unripe or diseased fruit, late rains, frost, etc. Understanding the wine making process will allow you to relate to and communicate better with the wine maker. The vineyard and the cellar are linked as by an umbilical cord and nothing happens to one that does not have an impact on the other. Appreciating what happens to the grapes after you deliver them to the crush pad – from the de-stemmer to wine store shelf – will add richness and satisfaction to your work as a grower. It will also greatly improve your relationship with the winery.

One thing you will have to accept is that in some years great fruit just won't happen. In a difficult vintage you can do everything humanly possible, but the fruit will not be fully ripe or may have disease problems or the harvest numbers just won't balance out. These are called "Wine Maker Years" when you hand over sub-standard fruit and say, "I did the best I could. Good luck." What results can a clever and creative winemaker extract from this fruit? It takes a person with special skills and the right tools to transform mediocre fruit into good wine. On the other hand, in the great vintages it is up to the wine maker not to mess up what you have achieved in the vineyard. These are the years that make conscientious wine makers the most nervous. In the East, the wine maker is as critical a contributor to fine wine as the grower, in some years even more important.

There are some very simple principles that should be kept in mind when it comes to the art of making wine:

- A great wine maker is able to achieve the right balance in his or her wines in both good and poor vintages, understands Eastern fruit and growing conditions, understands and respects the vineyard and the grower, shares the same stylistic goals, and has some notions of viticulture. Not being a prima-donna would be a plus. He or she should also have a great, internationally-trained palate.
- Key wine making skill set and pressure points:
 - Ability to communicate
 - Pulling the trigger: recognizing fruit maturity and when to pick
 - Primary fermentation (extraction in reds, aromas in whites)
 - Blending (especially red wines)
- The winery must be clean, functional, and well designed

- The winery has the best, most up-to-date equipment possible, including new tools such as reverse osmosis and rotary fermentors
- The winery's sanitation practices should be sound; this will show clearly in the facilities
- The winery should be easy to clean
- Good drains: wine making is all about cleaning. How is the effluence removed?
- Good laboratory facilities and knowledge
- Plenty of room to work: figure out what space you will need and then double it.

As a grower who takes pride in your fruit, you should hold the winery to the same, if not an even higher standard. A good wine does not have to come from a fancy, expensive facility. In fact, some of the most outstanding wines are made in pole barns of greater or lesser simplicity. In every case, however, the right equipment and design features – even such an obvious thing as adequate drains – can make all the difference in cellar management and wine quality. Give your grapes the best possible chance to go the distance and be transformed into a fine wine.

Winemaking in the Eastern U.S.

*Rich Olsen-Harbich, Wine Maker
Bedell Vineyards
Peconic, New York*

Achieving quality and balance in red wines in the East first requires exceptional management in the vineyard and a dedication to producing quality over quantity. The variety of red grapes grown in a particular vineyard site should fit the ripening parameters for its terroir. In order to achieve these goals, a sufficient number of frost-free days need to be available for the red wine in question. Realistic expectations of the variety should match what the site can produce. For example, ripe Cabernet Sauvignon would be difficult to achieve in many northeastern vineyard sites due to the late ripening character of this grape. If you can have frost-free ripening conditions into November on a regular basis, then complete maturity of this variety is do-able. If not, go for earlier ripening red varieties such as Pinot or Merlot. Of course, the minimum winter temperature of the site must also come first and foremost.

I think there can also be a lot done in the northeast with varieties like Norton, Zweigelt, Lemberger and Noiret – the last one as a blending grape. In my opinion, the variety is less important than the quality and style of the red wine that can be produced in a given location. If the best and ripest red fruit you can grow is from Chambourcin, then that's the variety you should focus on, and try to make the best possible wine you can from it. The variety will change depending on the terroir – that's what makes the northeast so interesting as well as challenging. Having accurate historical weather data is also essential for growers who are just starting out.

Among the Bordeaux reds, Malbec is by far the earliest ripening. However, this variety is also the most tender of the Bordeaux reds, requiring prime vineyard sites in order to survive. Pinot Noir is one of the earliest ripening of the noble varieties; however, it has been preceded by a reputation as a difficult grape to ripen and vinify. Cabernet Franc is one of the hardiest reds grown in the northeast, but again it is late and requires rigorous fruit thinning and a lot of patience in the fall. Once you've established the variety that will do the best on your site, you'll need to implement solid vineyard management in order to bring the fruit to the winery in the best possible condition.

A good management program for all growing seasons in the northeast needs to include the following:

- Good disease and insect management to ensure a healthy canopy through to the end of the season
- Shoot thinning to open up the canopy to light and air
- Rigorous fruit thinning to insure adequate ripeness in any given season. Our goal at Raphael is approximately 1 cluster per shoot, or about 2 to 2.5 tons per acre
- Leaf removal around every cluster to expose the fruit to light and air
- Proper hedging during the growing season
- Protection from predators like deer and birds
- Hand harvesting of the fruit

In a great vintage like the one in 2007, the vine can carry more fruit and get it ripe. However, since we are not yet able to predict the future, we don't know how the season will finish while we are in the middle of it. Many fruit thinning decisions should be performed after bloom; these numbers are often in place regardless of the quality of the vintage and are a safe bet. Thinning is essential to getting the ripe fruit flavors, ripe tannins and low acid levels needed in quality red wines.

Studies done at Cornell in the last year also indicate that earlier leaf removal results in lower levels of methoxy-pyrazines (green flavors) at harvest.

Winemaking continued >

Olsen-Harbich: winemaking...

My main goal in any vintage is to harvest Bordeaux reds with ripe berry flavors and zero tolerance for any green or unripe character. This requires a long hang time for the fruit. As we have a serious bird problem, our vines need to be netted in order to achieve this required hang time. Beginning at veraison (in mid- to late August) and until harvest at the end of October through early November, the fruit is covered by netting. Hand harvesting is also essential when working with the best fruit. We hand harvest and also sort at the winery in order to make certain that we have only pure fruit going into the tanks. In my view, for small vineyards in the northeast hand harvesting is another important factor in producing high quality red wines.

My harvest parameters involve little in the way of scientific analysis; they are instead based on tasting the fruit and visual inspection. I pay absolutely no attention to the pH of the fruit at harvest, as I feel that this parameter is given too much importance and can lead to under-ripe fruit at harvest. Higher pHs in the range of 3.5 and above are nothing to be afraid of, and in my opinion it is more important to have ripe flavors, low acid and mouth-filling tannins. For reds in the northeast, there is little reason to pick before absolutely necessary. I'm looking for specific berry flavors, dark crunchy seeds, and slight desiccation; for me these are the signs of absolute ripeness for any vintage. Dark crunchy seeds are an important indicator as I can expect the tannins to be fully ripe at this point. I also like to chew the skin to get a feel for the tannic profile.

The time to harvest is the most important decision a winemaker will make all year and one should be in no rush to make it. I wait until it looks as though the fruit is beginning to shrivel before picking any grapes. This indicates a closure of the ripening process and will usually lead to riper tannins, lower acid levels, and darker, more extracted wines in the cellar. As we all know, some years will just turn out to be better than others – but if you push your fruit as far as it can go, you'll know that you've done all you can do in the vineyard.

My basic parameters for harvesting ripe fruit for any vintage are as follows:

- Ripe varietal character, flavor and aroma;
- Brown, crunchy seeds that fall apart easily in the mouth;
- Ripe tannins in the chewed grape skins;
- Color is easily released from broken grape skins;
- Fruit is beginning to desiccate and/or begins to fall off the clusters with gentle shaking.

Sanitation in the cellar is very important as well. Every aspect of the cellar should be clean, from the floor and drains to the tops of the tanks. I don't let any chlorine products into my cellar, so most of our cleaning is done with light soda ash, citric acid and metabisulfite.

My vinification techniques are rather straightforward, as I'm looking to create a sustainable approach in the winery. I rarely chaptalize, because the natural sugar in the fruit is usually the best level for the wine to achieve proper balance. No additives, enzymes or tannins are used in my cellar, although for certain varieties you may want to play around with them to see if they might work for you. I use a fairly gentle regimen of minimal pump-overs and gravity flow rackings into barrels. Maceration length will depend on the vintage and on the ripeness level (flavor and tannins) found in the fruit. For very ripe years I will go longer on the skins, while in a cooler year where the fruit may be more delicate, I'll press much earlier, sometimes in as little as one week. Leaving less-ripe fruit on the skins longer as a way of increasing body and mouth feel is a mistake in my opinion. Riper fruit can withstand a longer aging period and a larger percentage of newer wood. I try to keep sulfur levels to a minimum so that the wine can breathe and develop more while in the barrels. I also like to bottle my reds without filtration, which can be achieved through careful racking and by working clean.

In the final analysis, the secret to success lies not in the wine cellar but in vineyard management and the weather conditions of the vintage. No amount of creative winemaking can turn average fruit into an extraordinary wine. However, with proper site selection and varietal affinity for the terroir, careful work in the vineyard will consistently produce high quality red wines in any given year in the northeast.

Some Final Thoughts

I just love getting up every morning and thinking about how to grow a better grape. It is really just intellectual candy and does not fit into the category of “saving the world.” But wine has been a part of human civilization for 9000 years and so it must have some importance to us. The challenge of growing a great grape is irresistible and a lot of fun. I can honestly say that after almost 30 years in the wine business, I am never bored. There is always so much to learn and we have so much further to go.

Wine growing is the synthesis of so many interesting disciplines: science, art and craft, agriculture, business, marketing, psychology, ecology and more for the production of a complex beverage. It is a careful blend of tradition and modern science and technology. It has been interesting to observe over the past two decades how New World wine regions like New Zealand, Chile, California and Oregon closed the quality gap with the Europeans so quickly using technology as their propellant. But at some point, the best producers realized that technology alone cannot craft a great wine. It was necessary to incorporate the wisdom of centuries of experience to find the best balance point for a wine. Old World wine regions embraced technology, only to discover that it was not the answer to their dreams but that the best wines resulted from a blended production method. As I travel the wine world, it is remarkable to see the similarities in ideas, methods, and technologies. Those who take a global view of their wine making are often the most successful. Many of the ideas and inspiration that make a great wine in the Medoc are also hard at work in Oakville. Yet, it is the subtle differences in terroir that make the Cabernet Sauvignon so unique to each region.

I am constantly amazed by the diversity, passion and determination of the people in the wine industry. Often with little or no agricultural training, most manage to develop very competent vineyards, some outstanding. It is a testimony to their ability to acquire and process new information and technology and put it to work. It is a pleasure and privilege to work with you.

People in this business tend to work hard, feel passionate about what they are doing, and enjoy living well. We are a sociable, convivial bunch. Our ultimate goal is to be able to sit down at the table with good food, and friends and family, and uncork a wonderful bottle. This gracious beverage has been a welcome guest at our tables for thousands of years, and as a wine grower you will be carrying on a venerable tradition.

Some observations accumulated over the years on how to grow good wine in the East

1. Quality is the most important goal for all wines regardless of type, style or price point.
2. Quality, price, and your investment in time and money will often be highly correlated.
3. Start small and grow gradually into a vineyard, as you learn and succeed.
4. The other option is to start big, but make certain that you heed every item in this list.
5. Have a plan and think ahead.
6. Keeping things simple is almost always better. Do not over-design or over-build.
7. Taking short cuts or skimping on the quality of materials and installation will almost always cost you more in time, expense and aggravation in the end.
8. Organization, planning and attention to detail will pay quality dividends in the fruit. Do everything WAY ahead of time (Jan Waltz).
9. PLEASE, do not reinvent the wheel. This has all been done before. Get good advice and listen to it!

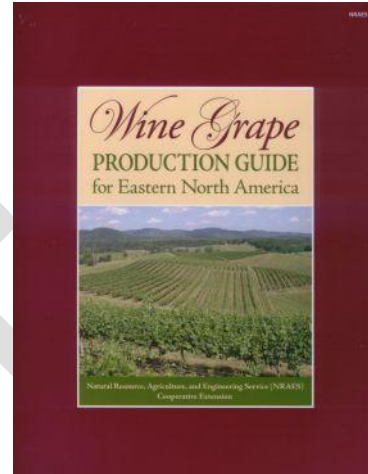
In a wet climate such as that of the Eastern U.S., here is what to look for if your goal is high-quality wine production:

10. An exceptional vineyard site. Look for one that is well drained to excessively well drained (TAW 2.5-4.5).
11. Areas with rain shadows or low precipitation.
12. The correct match between climate and grape variety.
13. Low to moderate soil fertility (especially nitrogen), cation exchange capacity, pH, and organic matter.
14. Slope – the steeper the better (up to 30%) and south facing.
15. If possible, a NE-SW row orientation.
16. Aim for small to medium size vine, high-density viticulture, i.e. > 2000 vines/acre and limited yield per vine.
17. Evaluate and design for optimal vine size and balance, and earlier fruit maturity.
18. Low vigor rootstock – RG, SQR, 101-14, 420A (in some cases)
19. The very highest quality plant materials. If possible use a nursery consultant.
20. Outstanding viticulture practices
 - a. Canopy: balanced, open
 - b. Fruit zone:
 1. 50% – 75% exposed fruit clusters
 2. Correct yield adjustment for wine style
 - c. Limit nitrogen to control vine vigor
 - d. Achieve mild water stress (according to soil moisture conditions)
 - e. Apply world-view viticulture ideas and best practices

- f. A skilled, experienced field crew and vineyard manager (you?)
 - g. The right equipment for the task, from tractor to pruning shear.
 - h. A high-quality trellis system
22. Be empirical: learn to observe, identify cause and effect connections in the vineyard, be proactive rather than reactive, enhance your intuitive powers, learn how to read conditions such as the weather.
 23. There are various measure that you can resort to when conditions require it, such as cover crops, root restriction, root pruning, drain tile, French drains, vigor diversion canes and crop, drastic hedging. These are only band-aids applied *ad hoc* to compensate for site deficiencies, but can help in difficult vintages.
 24. Farming is all about problem solving. If you are not good at this, you probably will not be a good farmer.
 25. Wine growing is highly specialized farming, with the goal of producing fine wines.
 26. Fill in your knowledge and experience gap, and then keep on learning!
 27. Taste benchmark wines critically and with tasters with more skilled palates than yours.
 28. Travel to other vineyards far and wide. Observe, learn, test and implement.
 29. With regard to points 23 and 24, always ask, “How did they do it?” Then find out in detail exactly how.
 30. Be passionate about your vines and wines.
 31. Share and participate in the efforts of fellow wine makers and the industry.
 32. Have fun and don’t ever forget why you are doing this. One grower told me that he’ll never work another day in his life. He has found fulfillment in the vineyard.

Selected Reference Resources for Winegrowers

The *Wine Grape Production Guide for Eastern North America* (2008), edited by Dr. Tony Wolf at Virginia Tech, is a technical production partner to this practical manual and is highly recommended along with the following viticulture resources:



- Creasy, G. and Creasy, L. (2009). *Grapes*.
- Dami, I., et al. (2006). *Midwest Grape Production Guide*. Ohio State University Extension.
- Dry, P.R. and Coombe, B.G. (2004). *Viticulture. Volume 1: Resources* (2nd edition). Wineitles.
- Galet, P. (2000). *General Viticulture*. Oenoplurimedia.
- Hellman, E., et al. (2000). *Oregon Viticulture*. Oregon State University Press.
- Jackson, R.S. (2002). *Wine Science: Principles, Practices, Perception*. 2nd edition. Academic Press.
- Keller, M. (2009). *The Science of Grapevines: Anatomy and Physiology*. Academic Press
- Smart, R. and Robinson, M. (1992). *Sunlight into Wine*. Wine Titles.
- Wise, A. and Martinson, T. (2007). *Vine Balance: New York Guide to Sustainable Viticulture Practices*. Cornell University Cooperative Extension.
- Wolf, T., et al. (2008). *Wine Grape Production Guide for Eastern North America*. Natural Resources, Agriculture and Engineering Service.

The information resources list mentioned throughout these pages is called “Information Resources for Commercial Wine Grape Growers in Pennsylvania.” It is regularly updated and posted under the “Information Resources” tab of the Pennsylvania Wine Grape Network website.

You can subscribe to the Penn State Viticulture E-newsletter by sending a blank message to: WINEGRAPE-L-SUBSCRIBE-REQUEST@LISTS.PSU.EDU

Find more information about wine grape growing in Pennsylvania and around the region at the Pennsylvania Wine Grape Network web site <http://pawinegrape.com/>.

Author's Informal Table of Useful Measurements and Conversions

F > C: subtract 32 and multiply by 5, then divide by 9 or multiply by 0.555

C > F: multiply by 1.8 and add 32

or

$C = (F - 32) / 1.8$; $F = (C \times 1.8) / 32$

Hot day 104°F/40°C

Warm day 86°F/30°C

Mild day 68°F/20°C

Cool day 50°F/10°C

Freezing 32°F/0°C

Frost damage to vine tissue occurs at about 28°F/

Really cold! 0°F/-17.8°C

General threshold for winter injury to *vinifera* vines is -8°F/-22.2°C

Body temperature 98.6°F/37°C

Boiling water 212°F/100°C

Ounces to grams: x 28.35

Grams to ounces: x 0.035

Pounds to grams: x 454

Pounds to kilograms: x 0.45

Kilograms to pounds: x 2.2

US gallons to liters: x 3.79

Liters to gallons: x 0.265

1 liter = 2.11 pints

1 case (12 bottles 750ml ea) = 2.34 gallons

1 bottle (750 ml) = 16 x 1.5 oz pours

1 ml = 0.03 oz.

1 oz = 29.573 ml

A bottle of wine (750 ml) = 25.35 ounces; @ 4 oz/pour = 6.3 pours/bottle; @ 1.5 oz/taste = 16 tastes/bottle

1 cubic foot of water = 7.48 gallons and weighs 62.4 pounds

1 quintal = 100 kg or 220 lb

27,154 gallons in one acre-inch of water

Inches to mm: x 25.4

Inches to centimeters: x 2.54

Millimeters to inches: x 0.04

Centimeters to inches: x 0.394

Feet to meters: x 0.30

Meters to feet: x 3.28

1 meter = 39.37 inches

Miles to kilometers: x 1.61

Kilometers to miles: x 0.6214 (5/8 mile)

1 ton/acre (t/a) = 15.22 hl/ha; 1 hl/ha = 0.0741 t/a (Kramer says 1 t/a = 13.5 hl/ha)

Here are some useful conversions provided by wine writer Matt Kramer:

1 hl/ha = 0.0735 t/a

30 hl/ha = 2.2 t/a

35 hl/ha = 2.6 t/a

40 hl/ha = 2.9 t/a

45 hl/ha = 3.3 t/a

50 hl/ha = 3.7 t/a

60 hl/ha = 4.4 t/a

75 hl/ha = 5.5 t/a

100 hl/ha = 7.35 t/a

1 hectoliter (hl) = 100 liters = 26.45 gallons, which is equivalent to 133 bottles or 11.1 cases of wine (twelve 750 ml bottles contain 9 liters of wine).

1 hectare at 40 hl/ha will produce 440 cases of wine

1 hectoliter (hl) = 0.183 tons US1 tonneau = 9 hl

1 ton of grapes = 5.45 hl of wine; 727 bottles or 60 cases of wine

Acres to hectare: x 0.405

1 acre = 43,560 sq ft or 209 ft x 209 ft

1 hectare = 10,000 m² = 2.471 acres

Burgundy/Bordeaux approximate vine density – 7,000 to 10,000 (1 m x 1 m) vines per ha. One vine at 40 hl/ha will produce about ½ bottle of wine; 24 vines/case of wine.

Square miles to square kilometers: x 2.60

Vinifera vines need about 15-30 gallons of water per week at full canopy; 3 to 5 gallons per week for new vines.

1 journal = “the area of vines that can be worked by one man in a day”

Glossary

Abiotic: associated with or caused by non-biological factors such as weather conditions (hail, frost, drought, etc.), herbicide drift, mechanical damage from equipment, etc.

Acclimation: the period during the late summer and early fall when shoots stop growing and turn from green to brown, lignifying into a woody condition while acquiring cold hardiness.

Agronomy: the branch of agriculture dealing with field crop production (corn, soy bean, wheat, etc.) and soil management.

Annual: completing a life cycle in one growing season or one year.

Benchmark: a point of reference by which all entries in a given category are measured or judged. A benchmark wine is a classic reference wine within a given category (defined by variety, geographic origin, or other characteristics).

Best practices: the highest standard of cultivation practices for vineyards, as generally accepted among international, domestic or regional wine growing authorities and practitioners. Not necessarily the most efficient or cost-effective methods, but always those that result in a higher-quality wine.

Biotic: in this context, a problem caused by a living organism such as an insect, fungi, bacteria, vertebrate, etc.

Bulk density: the mass of dry soil per unit bulk volume, (expressed in grams per cubic centimeter). A bulk density >1.6 g/cc can restrict water storage and root penetration.

Calibrate: to adjust or check against a known standard, for example, a sprayer to deliver a precise amount of material to the vine or soil or to calibrate one's palate using benchmark wines.

Cation exchange capacity (CEC): a measure of the soil's ability to absorb and retain nutrients. In practical terms it affects the ability of vine roots to absorb nutrients from the soil.

CCA: chromate copper arsenate, a preservative used in pressure-treated wood posts. This substance is toxic and care must be taken to dispose of worn-out posts properly.

Chlorosis: abnormal yellowing of vine foliage due to a decrease in the amount of chlorophyll that can be caused by disease or nutrient deficiency.

Clone: a population of vines derived by vegetative propagation from a single (mother) vine with unique features that are different from other vines of that variety.

Compaction: a measure of penetration resistance of the soil, often caused by the repeated passage of equipment over a field.

Conservancy: an organization or area designated to conserve and protect natural resources. Many counties and states have conservancy programs to protect threatened farmland.

Continental climate: an inland climate characterized by winter temperatures cold enough to support a fixed period of snow, and summers with moderate, even levels of precipitation and humidity.

Cover crop: plant species grown between vine rows or under vines to reduce soil erosion or obtain other benefits such as green manure, suppression of weeds or a reduction in vine vigor.

Cultivar: a more technical term for variety (see *variety*).

De-acclimation: the process by which a grapevine transitions out of dormancy to actively growing.

Diurnal temperature range: the variation in temperature that occurs between the daytime maximum and the nighttime minimum.

Economic threshold: the critical level of damage caused by a pest (disease, insects, weeds, etc.) after which control measures must be taken to prevent unacceptable levels of economic loss to a crop.

Effective rooting zone (or effective rooting depth): the area in the soil, usually expressed as 'horizons', occupied by the majority of the vine's roots that are actively taking up water and nutrients, usually about half of the total rooting depth of plants.

ELISA (enzyme-linked immunosorbent assay): a biochemical test designed to detect antigens and antibodies. In viticulture it can be used to identify viruses, bacteria and other harmful organisms in vines.

Empirical: originating in or based on observation or experience.

Enology: the science of wine and wine making.

Fertigation: the application of fertilizers, soil amendments, or other water-soluble products through an irrigation system.

Fragipan: altered subsurface soil layers that can restrict root penetration and water flow.

Fruit wire: the trellis wire that supports the vine parts, such as the canes or cordon arms, which carry the shoots and grape clusters.

Garagistes: a group of small-scale, innovative wine makers in Bordeaux who started making 'garage wines' of notable quality in the 1990s and are continuing to this day.

GPS (global positioning system): a navigational system that uses satellites to determine fixed positions on or above the earth's surface.

Grape grower: a person who grows table, raisin, juice or wine grapes. Contrast with "wine grower."

Ground Truthing: Verifying conclusions drawn from various information resources with field based survey work. In the case of vineyard evaluation, using local site data to validate spatial data from GIS or remote sensing source.

Hard pan: a cemented or compacted and often clayey layer in the soil that cannot be penetrated by the vine's roots.

Harden off: another term for acclimation, the process of tissue conditioning for cold hardiness in the vine.

Herbicide: a type of pesticide, usually a chemical, that is used to kill unwanted plants.

Horticulture: the art and science of growing fruits, vegetables, flowers and ornamental plants.

Hybrid: the offspring from the crossing of two plants of different species or varieties. Also French hybrid and interspecific hybrid.

Integrated pest management (IPM): an effective and environmentally sensitive approach to pest management that relies on a combination of common sense practices.

Internode: the portion of the shoot between two nodes.

Laterals: the small secondary shoots that grow from the leaf axil during the summer.

Methoxypyrazines: chemical compounds that can produce positive and/or negative aromas/odors in wine, such as the grassy aroma in Sauvignon Blanc or the bell pepper, herbal aromas in unripe Cabernet Sauvignon.

Mid-Atlantic: an informal designation for a region in the East that encompasses Pennsylvania, New Jersey, Maryland, and Virginia (and sometimes also includes New York and West Virginia).

Mulch: a protective covering of, for example, sawdust, straw, compost, or paper that is spread or left on the ground to reduce evaporation, maintain an even soil temperature, prevent erosion, control weeds, and/or enrich the soil.

Mycorrhiza: the symbiotic association of the mycelium of a fungus with the roots of a plant, from which the fungus derives a source of carbon while the host plant gains increased access to the mineral nutrients in the soil.

Nematodes: small, often microscopic worms with non-segmented bodies, that can carry and transmit viruses when feeding on vine roots.

Node: the conspicuous joint of a shoot or cane where buds, leaves, laterals and tendrils originate.

Off-farm inputs: products such as pesticides and fertilizers that are brought into and integrated with the vineyard's ecosystem.

Organic matter: the residue remaining in the soil from the decomposition of plants and animals, expressed in percent of soil weight.

Organoleptic: being, affecting, or relating to the qualities such as taste, color, odor, and feel of a substance (such as juice or wine) that stimulate the sensory organs.

PCR (polymerase chain reaction): a laboratory procedure (like ELISA) that can be used to test for viral, bacterial and other trunk diseases in grapevines.

Penetrometer: an instrument used to measure the firmness (compaction) or consistency of a soil.

Perennial: a plant that lives for more than two years (as compared to an annual or a biennial).

Pesticide: an agent, usually a chemical substance, used to destroy a pest. In the vineyard pesticides are most often deployed against fungal diseases, weeds, and insects.

pH: a measure of the alkalinity or acidity of a solution on a scale of 1 to 7, in which a value of 7 represents neutrality and lower numbers indicate increasing acidity and higher numbers increasing alkalinity (from least to most acidic). Calculated as the negative logarithm of the effective hydrogen ion concentration or hydrogen ion activity in gram equivalents per liter of solution, each unit of change represents a 10-fold change in acidity or alkalinity.

Phenolics (noun: phenol): pertaining to the secondary plant metabolites that are largely responsible for the astringent and bitter taste in grapes and wines, and which play an important role in the stabilization of wine color.

Phenology: the study and recording of recurring biological phenomena in plants (such as bud break, bloom, and veraison) on the basis of elapsed time, heat accumulation and other climatic conditions.

Photosynthesis: the complex biochemical process in plants that converts light energy into chemical energy using carbon dioxide and water as source materials and producing oxygen and sucrose as end products.

Phylloxera: (*Phylloxera vitifoliae*): a tiny, aphid-like insect that feeds on grapevine roots and can weaken or kill a vine. It is the principle reason for grafting *vinifera* grape varieties.

Physiographic (physiography): pertaining to various areas of study in physical geography (such as ecology, hydrology, and climatology) that describe the features of a physical area.

Physiology: a branch of biology that deals with the functions and activities of living organisms, including physical and chemical phenomena. Plant physiology is the study of the biological functions of plants including the vine.

Phytotoxic: used to describe natural or man-made compounds that are injurious or noxious to plants or plant parts.

Production vineyard: A vineyard that grows grapes more as a commodity than a specialized wine product. Higher yields are a main objective to the grower.

Replacement viticulture: the practice of replacing/renewing vines or parts of vines that have suffered damage or injury, such as winter injury.

Reproduction: the physiological process of the vine involved in producing grapes and seeds.

Rootstock: the underground portion of a plant onto which the cutting from another plant (scion) may be grafted. In viticulture rootstocks are used to impart specific qualities to the grapevine such as phylloxera resistance, vigor reduction, lime or drought tolerance, etc.

Sensory: relating to the senses. In the case of berry, juice and wine analysis, the use of the senses to evaluate maturity and quality.

Subsoil: the strata of weathered material that lies beneath the soil's surface or topsoil.

Sustainable agriculture (American Agronomy Society, 1989): "A sustainable agriculture is one that, over the long term, enhances environmental quality and the resource base on which agriculture depends; provides for basic human food and fiber needs; is economically viable; and enhances the quality of life for farmers and society as a whole."

Synchronicity: happening, existing or arising at exactly the same time; in viticulture, the simultaneous occurrence of an event such as bloom, veraison, fruit maturity, etc.

Take: to successfully join together, such as the grafting of rootstock and scion or soil and plant, a term used to describe the relative success or survival of newly planted vines.

Tannin: any of a variety of complex, astringent, soluble, phenolic substances of plant origin.

Tensiometer: an instrument for determining the moisture content of soil.

Terroir: a French term that refers to a "sense of place" in viticulture and is embodied in the sum of the effects of local environmental conditions (soil and climate), the plant materials (varieties, clones and rootstock) and the human input (viticulture and wine making) in the production of wine.

Topography: the delineation of the natural and man-made features of a place or region in the form of a map or chart that also includes information on relative position and elevation.

Training: physical manipulation of the plant's form.

Trellis: a support system for built for vines with names such as Vertical Shoot Position, Scott Henry, Geneva Double Curtain, Lyre, etc.

Typicity: from the French *typicite*, it is the subjective character of a wine that describes the place where it was grown. Typicity is the result of the *terroir* of a wine.

Uniformity: the quality or state of being uniform (the opposite of variability). In the vineyard this pertains to the physical, biological, structural, and morphological aspects of the vines and consistency in the vineyard's structural systems (irrigation, trellising, etc.).

Variety (cultivar): an organism and especially one of an agricultural or horticultural variety or strain such as an agricultural or horticultural subspecies originating and persisting under cultivation.

Vector: an organism, such as an insect or nematode, that transmits a pathogen such as a virus.

Vegetative: the phase of foliage production by a plant during the growing season (in contrast to its reproductive phase).

Veraison: the period or stage at which fruit begins its third state of ripening, characterized by softening of the skin, color change, and a perceptible increase in sugar and decrease in acidity.

Vertebrate: in the context of the vineyard, a vertebrate animal that can do damage to vines (birds, deer, bears, rabbits, raccoons, mice, voles, etc.).

Vigeron: 15th-century French term derived from *vigne*, denoting a person who cultivates a vineyard to make wine.

Vigor: the rate of shoot growth. Also, informally, the size of a vine or the capacity of a soil (as in "a vigorous vine" or "a vigorous soil").

Viticulture: the study and cultivation of grapevines.

Vitis vinifera: the genus and species of grapevine that originated in Eurasia and has been cultivated to make wine for centuries.

Water witching (also called “dowsing”): the practice of locating something, such as water for wells, without using scientific instruments.

Wine grower: a person who grows grapes specifically for the purposes of making wine, usually with the goal of producing a high quality wine.

DRAFT