# Production Budgets for Arkansas Wine and Juice Grapes

Emilio Noguera, Justin Morris,
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**Emilio Noguera**
Former Research Assistant
Dept. of Agricultural Economics and Agribusiness

**Justin Morris**
Distinguished Professor
Institute of Food Science and Engineering and
Dept. of Food Science

**Keith Striegler**
Assistant Director — Viticulture
Mid-America Viticulture and Enology Center
Southwest Missouri State University
Mountain Grove, MO 65711
*Former Extension Specialist, Department of Horticulture at the University of Arkansas*

**Michael Thomsen**
Associate Professor
Institute of Food Science and Engineering and
Dept. of Agricultural Economics and Agribusiness

**Arkansas Agricultural Experiment Station**
**Fayetteville, Arkansas 72701**
***(a unit of the University of Arkansas System's statewide Division of Agriculture)***

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# PRODUCTION BUDGETS FOR ARKANSAS WINE AND JUICE GRAPES

**Emilio Noguera, Justin Morris, Keith Striegler, and Michael Thomsen**

## Abstract

Production budgets are presented for wine and juice grapes suitable for cultivation in Arkansas. Varieties examined include *V. labruscana*, French-American and American hybrids, *V. aestivalis*, *V. rotundifolia*, and *V. vinifera*. Important production considerations specific to each of these varieties are summarized. Results indicate considerable variation in profit potential among varieties. However, one or more varieties can be profitably grown in most regions of the state. With the exception of Sunbelt, *V. labruscana* varieties showed the least profitability. *V. rotundifolia* (muscadine) varieties hold promise as a new crop for the warmer southern regions of Arkansas, while Chambourcin shows strong profit potential as a red wine grape in parts of the state with more temperate climates. Other promising varieties include Chardonel, Traminette, and Cynthiana. *V. vinifera* varieties also show strong profit potential, but are limited by their intense management requirements and can only be grown on the best sites.

## Introduction

This study estimates the costs, net returns, and break-even points for wine and juice type grapes suitable for production in Arkansas. The purpose of the study is to update earlier cost-and-returns studies released by the Arkansas Agricultural Experiment Station (Kirchner, Price, and Morris, 1988; McCollum, Price, and Morris, 1996) and meet the following objectives:

1. Provide cost information to growers, wineries, and processors considering a new wine or juice grape enterprise or expanding an existing enterprise.
2. Provide background on the economic situation facing grape producers in Arkansas.
3. Communicate best practices specific to Arkansas climatic conditions for selected varieties of wine or juice grapes.

For the operations outlined in the budgets, it was assumed that vineyard management would be near optimal and that all recommended practices would be followed. The recommendations were drawn from people with expertise in grape production and research at the Arkansas Agricultural Experiment Station and wine industry management level and, if all operations were put into practice as listed, it would be considered a relatively high level of management. The assumption was made that all recommended activities would be included. The costs were calculated as if the grower started with a bare field and followed the budgeted pattern.

Grapes are planted in the spring. The first harvest is usually in the third year after planting, and maximum production is reached in about the fifth year. As reported by local vineyards, a vineyard with proper care should remain productive for 30 years or longer. Land preparation, planting, cultivation, spraying, etc. through 30 years of vineyard life were included in the budget requirements, resource inputs, and resulting costs and revenue. After the information was assembled and processed, the authors, working as an interdepartmental committee, again checked each estimate to insure its accuracy.

Experiences of growers and research specialists were used to project the yield obtainable with each variety. The estimated quantities represent an average of the marketable product that some growers currently attain. Research results were used where applicable.

Whole analysis assumes good management in terms of production, technology, and disease and insect control measures. The projected yield for each variety, although higher than Arkansas' average, is attainable and can be exceeded if growers follow recommended production practices. To address risk of yield variations due to natural disasters, adverse weather such as frost or hail, and other unavoidable environmental variations, the averages were reduced by 10% to reflect potential loss. Although it was recognized that each variety would not necessarily be at equal risk for hazards such as frost/freeze damage, the hypothetical 10% reduction in average yield potential was applied to all varieties. In general, improved management should increase the yield of grapes to the level estimated while reducing the variability of yield and quality.

Price data for various inputs used in grape production were gathered during the spring and summer of 2003. Most prices used in the budgets represent input from local suppliers, suppliers accessible to producers in the region, or individuals familiar with grape production in the region. In a few cases, figures in-line with existing enterprise budgets covering grape production in the middle and eastern United States were used (Avery et al., 2003; White and Pisoni, 2001; Domoto, 2001; Erb, Tisserat, and Warmann, 1999). The interested reader is directed to appendix A for a list of all prices and rates used in the budget calculations. Rate and price assumptions commonly encountered in the narrative that follows are:

- A 6.3 percent interest rate for purposes of amortization and calculation of operating interest expenses.
- Tax and insurance rates for structures and machinery of 0.5 percent and 0.6 percent, respectively.
- Hourly labor rates of $8.29 for unskilled and irrigation labor and $9.50 for machine operator labor.
- A price for diesel fuel of $1.37 per gallon.

The remainder of this report is organized as follows: the next section describes production considerations important to grape production in Arkansas, provides a general overview of the varieties covered in these budgets and their suitability to particular regions of the state, and addresses general considerations in selection of a vineyard site; next, assumptions used to construct the budgets are outlined with specific emphasis on establishment costs related to trellising, irrigation, and machinery; and the last two sections present budget results and include estimated net returns for mature vineyards along with break-even price and yield points.

## Production Considerations for Arkansas Grape Production

### Disease and Insect Considerations

Loss of wine grapes to disease and insect damage is no greater a problem in Arkansas than in other states with similar environmental conditions. Economically feasible and technologically sound control programs have been devised for most diseases and insect pests (Johnson et al., 2004).

Black rot (*Guignardia bidwelli*), downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*), bunch rot (various fungi), and anthracnose (*Elsinoe ampelina*) are the most serious diseases of wine grape species grown in Arkansas. In black rot, the fruit rots, blackens, shrivels, and is covered with tiny black pimples. Leaves show brown spots, which have gray centers with black pimples. Black rot is prevalent and will cause complete destruction of the crop if not controlled. Downy mildew and powdery mildew are primarily foliar diseases. Leaves infected with downy mildew have indefinite yellowish areas on the surface of the leaves with white downy patches beneath. Powdery mildew appears as a powder-like dusting over the entire upper surface of the grape leaf. Plants infected with these mildews can yield fruit with poor size, color, and flavor. Although significant fruit damage can result from infection during or near bloom period, loss of plant vigor from premature defoliation is usually the most significant factor in failure to control downy and powdery mildew. All grape species, especially the *V. vinifera* and French-American hybrid vines, can suffer serious winter injury from premature defoliation. Anthracnose is a problem on *V. vinifera* and French-American hybrid grapes, a moderate problem on some *V. labruscana*, and little or no problem for *V. rotundifolia* and *V. aestivalis* grapes. It is caused by a fungus and can attack all parts of the vine. Other disease problems may be significant in a specific year and/or vineyard; however, many of these diseases are controlled by the same sprays that control downy and powdery mildew.

The grape berry moth (*Endopiza viteana*) is a small brown worm that attacks the fruit, causing fruit to color prematurely, crack open, or shrivel and drop from the bunch. The yield loss for most varieties is small, but if not controlled, damage from this pest may result in unacceptable quality of the crop. For varieties that are susceptible to bunch rot, berry moth damage can lead to increased incidence and severity of the disease. Climbing cutworms (Lepidoptera: Noctuidae) and flea beetles (*Altica chalybea*) can reduce yields by destroying the buds. These insects are often present, but infestation levels are not always high, and they can be controlled with insecticides. Grape scale (*Diaspidiotus uvae*) was a major insect problem in the past but has not been a significant problem in recent years. However, grape scale outbreaks should be monitored, since a population buildup is occurring in a few isolated vineyards. Control measures should be implemented when scale is observed. Grape root borer (*Vitacea polistiformis*) can attack the root system of the vine and reduce the vigor and vine numbers to a point that the vineyard is no longer an economic enterprise.

The Japanese beetle (*Popillia japonica*) is a very destructive pest and has become established in areas of Northwest Arkansas starting in 2001. The adult beetle feeds on all grapevines and, if not controlled, will totally defoliate the vine. They usually appear around June 15 to June 20 and last for six to eight weeks. The adult beetle feeds on the foliage of hundreds of different plants, but the grape is particularly preferred. The larvae feed on the roots of many plants, but especially on grasses. It is likely that this insect has been brought into the area on sod and landscaping material.

The green June beetle (*Cotinis nitida*) can attack the ripe fruit and can be a problem on early, high-sugar varieties.

Effective control of grape diseases and insects is available through the use of pesticides along with good viticultural practices. The sequence and timing of pesticide applications given in this report were suggested by the Arkansas Agricultural Experiment Station, Arkansas Cooperative Extension Service and wine industry representatives and should apply to a broad range of grape growers. The Arkansas Cooperative Extension Service provides recommendations for selection of pesticide and fungicide materials and timing of application. Cooperative extension agents and state extension specialists can help in developing a spray schedule that is applicable to an individual situation.

**Special Requirements for Growing the Various Grape Species**

Three major factors that dictate where the various species and varieties of grapes can be grown are site, soil, and, most significantly, climate. The winter weather in Arkansas can vary from mild to extremely cold, and these fluctuations in temperature can result in serious injury to grapes, especially to the *V. vinifera* and *V. rotundifolia* species in the northwest and north-central parts of the state. Summer climate can be extremely hot and humid and, therefore, conducive to disease growth. This puts a further limitation on the best sites for wine grapes.

*V. vinifera*. The hardiest of the *V. vinifera* varieties can be successfully grown only on the best sites. Winter hardy varieties such as Riesling, Chardonnay, Cabernet Franc, and Cabernet Sauvignon have been grown commercially in Arkansas and are considered to be the most cold hardy and most adapted varieties for special selected sites and soils in Arkansas. In Arkansas, the majority of the best sites for *V. vinifera* grapes are located below the coldest sections of the state in the foothills of the Ozarks and other similarly protected areas. In the extreme southern portions of the state, the major obstacle to growing *V. vinifera* grapes is Pierce's disease (PD) (*Xylella fastidiosa*). PD is a killer of grape vines that is spread by certain kinds of leafhopper known as sharpshooters. PD is restricted to the southern portions of the state which have mild winters that allow for the over-wintering of the bacterium in infected vine tissues. PD infects many plant species; however, most are symptomless, and these host plants serve as a source for the leafhopper vectors to pick up the PD bacterium for transmission to the grapevine.

Grape phylloxera (*Daktulosphaira vitifoliae*) is an aphid-like insect that attacks *V. vinifera* grape roots resulting in stunted growth and eventual vine death; it can also be found on wild species of grapes growing in the eastern United States. Phylloxera reproduces rapidly and goes through several asexual generations each year. The winged form of phylloxera, found in Arkansas and other eastern grape-growing regions, has a sexual stage that results in the formation of leaf galls. The nymphs that develop fall to the ground and attack susceptible roots. The only defense against phylloxera is to graft the desired *V. vinifera* variety onto a resistant or tolerant rootstock.

One of the better training systems for producing *V. vinifera* in cold climates such as the foothills of the Boston Mountains (Ozark Mountains) is the vertical shoot positioned system. Vine management must be designed to anticipate and compensate for cold injury. Some growers train up two trunks and periodically remove a trunk every 4 to 6 years especially if crown gall (*Agrobacterium tumefaciens*) forms as a result of wounds caused by freezing injury. The swellings, or galls, are most common on the trunk near the soil line; however, secondary galls can form higher on the trunk and cordons. Gall formation disrupts the food- and water-conducting tissues of the vine. Graft unions are protected by plowing a mound of soil over the base of the vines in late fall to insulate the graft union and to protect the renewal zone. The soil is moved away from the graft union in the spring. This process is repeated for 3 or 4 years, at which time the graft and vine can better withstand cold injury.

*V. rotundifolia*. Muscadine grapes (*V. rotundifolia*) have winter hardiness levels similar to *V. vinifera* and are usually considered adaptable in regions that can grow cotton and pecans. They can be successfully produced only in the central and southern regions of the state. They have the advantage of not being as seriously affected by disease or insects as other grape species and can be produced with approximately one-half the sprays required by French-American hybrid or *V. labruscana* grapes.

There are two types of muscadine grape varieties planted in Arkansas: pistillate, or female-flowering types, and self-fertile, or perfect-flowering types. The pistillate vines have flowers that produce only ovaries (fruit) and contain no anthers or pollen. Pollen for the female-flowering vines must be provided by interplanting these types with self-fertile plants. The self-fertile vines have both ovaries and pollen and can pollinate themselves as well as the female-flowered varieties.

Carlos and Noble varieties have been commercially planted for juice and wine production in Arkansas. Carlos is a bronze variety of excellent quality and aromatic flavor; it ripens fairly uniformly and produces quality wine. The plant is vigorous, open, upright in growth, productive, and somewhat hardier than most other popular varieties. It is also suitable for mechanical harvesting. Noble is a red variety that is relatively winter hardy and makes a quality red wine. Noble ripens uniformly and is adapted to mechanical harvesting. Both of these varieties have perfect flowers and are self-fertile. Nesbitt, Summit, and Black Beauty are fresh market varieties that have been made into successful juice products. A processing market alternative is important if and when the fresh market fails.

Muscadine grapes are adapted to almost any well-drained, moderately fertile soil with a pH of 5.5 to 6.5. They are adaptable and native in many regions of the state. The minimum temperature the vines can withstand depends on vine condition and weather conditions that precede low temperatures. Fluctuations of temperatures from high to low can be as damaging as an absolute low temperature because grape vines can deacclimate (lose their winter hardiness). It is best to plant muscadines in regions where the winter temperature stays above 0°F.

Unlike vineyards of other grape species produced in Arkansas, the width of the rows in muscadine vineyards may vary from 9 to 12 feet. The minimum spacing of vines in the row is 20 feet. A 9 x 20-foot spacing only requires 242 vines per acre. *V. vinifera*, *V. labruscana*, and French-American hybrid varieties require 544 to 680 plants per acre depending on species, variety, and recommended vine spacing.

***V. labruscana***. Varieties of the *V. labruscana* species and their hybrids are not as susceptible to winter temperature fluctuations as the *V. vinifera* varieties and can be grown over a wider range of climatic conditions. The Concord variety (*V. labruscana*) has proven to be best adapted to the climatic region of northwestern Arkansas. Concord grapes will not ripen properly or uniformly in the warmer regions of the state. This problem of uneven ripening has not been a limiting factor in the production of the Niagara, Catawba, or Delaware varieties in the warmer regions of the state; however, the Arkansas Agricultural Experiment Station has recently released a new high-quality Concord-like juice grape variety, "Sunbelt", adapted to all regions of Arkansas where bunch grapes are grown.

**Hybrids**. The hybrid grapes that are grown commercially in Arkansas can be grouped into two categories, 1) the French-American hybrids and 2) the American hybrids. In general, the hybrids fit somewhere between the *V. vinifera* and the *V. labruscana* species in terms of susceptibility to winter injury and ability to adapt to various climatic regions of the state. The French-American hybrids or "French Direct Producers" are the results of crosses made by French hybridizers to develop grapes that would be tolerant to the phylloxera root louse and resistant to fruit and foliage fungal diseases. Many varieties were developed that were easy to grow and did not require grafting. In making their crosses, the French hybridizers avoided *V. labruscana* (a strong, foxy-flavored grape) as a parent in their crosses. These grape hybridizers instead used other American species whose fruit was nearly neutral in flavor to cross with the *V. vinifera* species. The results were hundreds of varieties. Most of these were not very good, but some produced very good wines. Extensive testing at the Arkansas Agricultural Experiment Station has resulted in the recommendation of Chambourcin (red), Seyval (white),Vidal (white), and Vignoles (white). These varieties make up the major acreage of the wine grapes that are, or could be, grown in this region.

Many of the American wine grape hybrids have been developed by grape breeders at the New York State Agricultural Experiment Station in Geneva. Three white grape varieties that are recommended from the New York program and selected for this research report are Cayuga White, Chardonel, and Traminette.

Evaluation of American hybrid wine-grape breeding lines continues at the Arkansas Agricultural Experiment Station and a few other public institutions. A few private breeders continue to hybridize wine grapes with the hopes of coming up with something better for Arkansas and the eastern United States.

***V. aestivalis.*** Cynthiana (*V. aestivalis*) is native to Arkansas and is adapted to most regions of the state. One of the major limiting factors to production of this species has been extremely low yields (around two tons/acre). However, research at the Arkansas Agricultural Experiment Station has shown that yields in the range of four to six tons are possible when optimal cultural practices (trellis system, pruning severity, canopy management, etc.) are used.

### Vineyard Location Requirements

Site selection is an extremely important component of successful grape production in Arkansas. Favorable vineyard sites are on hilltops or hillsides with elevations above adjacent valleys and with unobstructed airflow from the site. The site elevation is important from the standpoint of air drainage, a determining factor in frost prevention. Site exposure, or orientation, may offer an additional advantage in terms of wind protection and temperature moderation at harvest. To gain the advantages of elevation and exposure, choice vineyard sites are frequently found on sloping lands that provide both water and air drainage. However, excessive slope on a site may impose serious limitations on vineyard layouts, erosion control, and machinery operations.

Soil is a prime consideration in site selection, and the most important soil factors are surface and internal drainage and moisture retention. Well-drained, moderately fertile, sandy or gravelly loam soils with a moderate rooting depth (two to four feet) and high organic matter with permeable subsoil are best. Shallow soils that are well drained may be the best to avoid excessive vine size; deep soil is certainly worse than shallow soil from the standpoint of controlling vine size when drip irrigation is used. For grape vineyards, soil with a pH of 5.5 to 6.5 is preferred. A Cooperative Extension Agent and/or State Extension Specialist can help review soil maps to evaluate suitability for vineyard location. In addition to the factors mentioned above, consideration must be given to the availability of adequate water of a suitable quality for irrigation.

In selecting a location, consideration also should be given to accessibility to vineyard equipment and chemical supply companies, equipment repair service, transportation, and handling facilities. Also, vineyards with access to public services, such as research and advisory programs, will have advantages over remote locations.

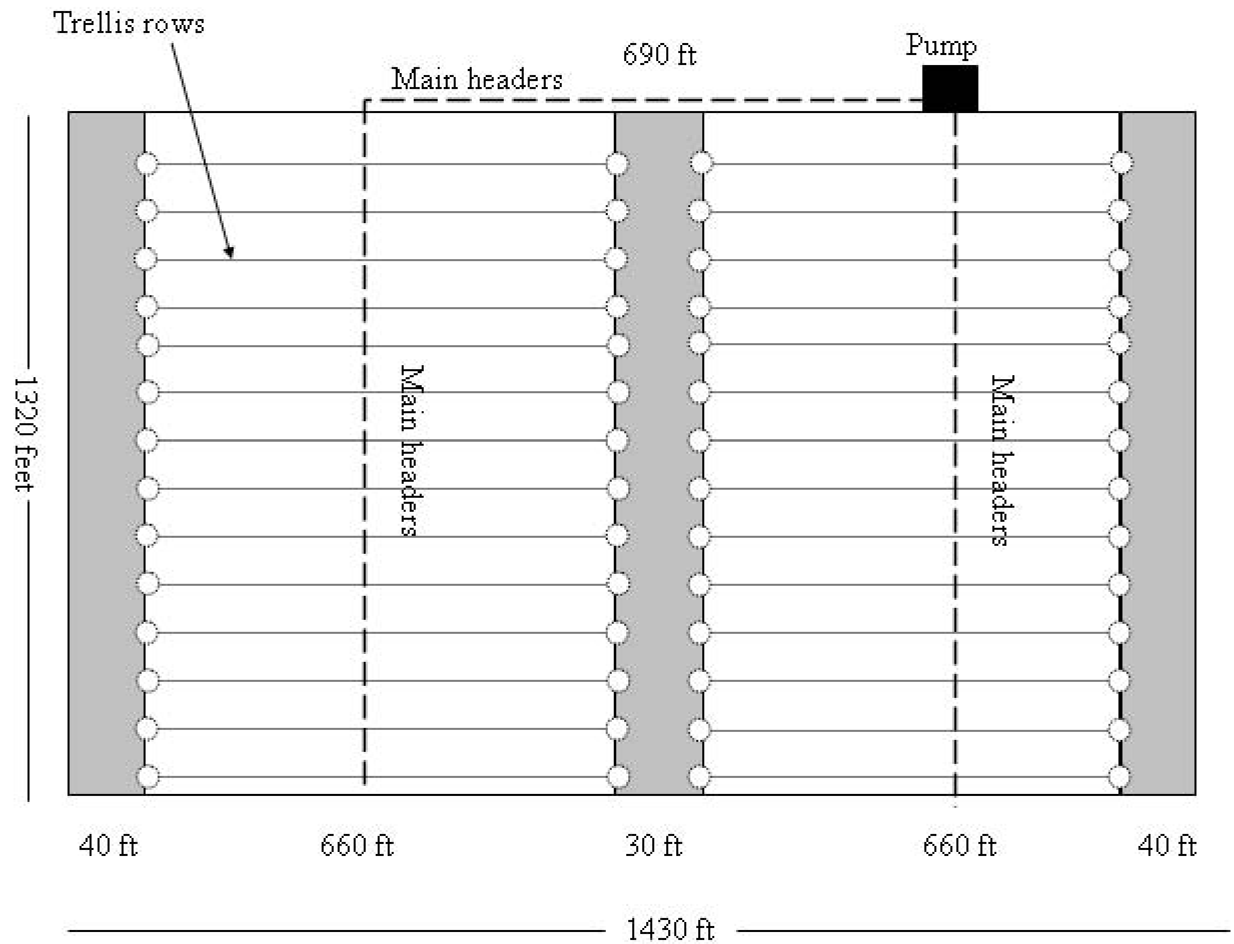
## Vineyard Establishment and Operating Costs

The budgets represent a farm with 40 acres of producing vines. It is assumed that this acreage is rectangular in shape, relatively flat, and is without trees or major topographical landmarks. Figure 1 provides a visual layout of the vineyard used for purposes of these budgets. The vineyard includes 40 foot turn rows and a 30 foot central alley (shaded areas in Figure 1). The turn rows and alley are to facilitate machinery operations. Producing vines are located on two regions, each 660 feet by 1,320 feet, and together total 40 acres of producing vines. The entire acreage, including the turn rows and center alley, totals 43.3 acres.

### Trellis Systems

A trellis system is required to provide support for grapevines. Two types of trellis systems are used in these budgets. Both are appropriate to the soil and climatic conditions in Arkansas and are also are adapted for a fully mechanized production system. The first is a single curtain bilater-

**Figure 1. Layout for Example Vineyard.**




al cordon system (SCBC) and, with the exception of *V. vinifera* varieties, is used for all varieties covered by these budgets. The SCBC system uses two support wires, one heavy-duty top wire (9 gauge) positioned 5.5 to 6 feet above the ground and a stabilization/vine catch wire (12.5 gauge) positioned 12 inches below the top wire. In an SCBC system, the trunk is attached to the top horizontal wire. Two cordons are developed from the top of the trunk, extended horizontally 3 or 4 feet in each direction, and secured to the top wire. Advantages of the SCBC system are (Striegler, 2004):

1. It uses few inputs (only two wires for vine support).
2. Pruning is relatively simple and canopy management inputs are reduced.
3. Disease control is usually easier than for other systems.
4. Grapes can be easily machine harvested.

The second type of trellis system, in these budgets used for *V. vinifera* grapes, is a vertical shoot-positioned system (VSP). The main feature of this system is moveable catch wires. The cordon height is 38 inches from the soil surface and is secured to a 9-gauge wire. The first set of moveable catch wires is positioned 46 inches from soil surface, the second set is positioned 58 inches from surface, and the third set of moveable catch wires is 70 inches from soil surface. All moveable catch wires are 13 or 14 gauge. A fixed wire at the top of the post is at 76 inches from the soil surface and is 12.5 gauge.

Table 1 lists the inputs used for the trellis systems. With the exception of muscadines (*V. rotundifolia*), all varieties covered in these budgets are assumed to be planted with an 8 foot by 8 foot spacing (8 feet between vines and 8 feet between rows). For muscadine grapes, the spacing is 20 feet between vines and 9 feet between rows. It is assumed that treated wooden posts are used for end posts in each trellis system. Wooden line posts are used for the SCBC trellises and metal line posts are used for VSP trellises. To accommodate VSP systems, metal line posts are available with indentations for the moveable catch wires. For vineyards with the 8 foot by 8 foot framespacing, 165 rows are in each of the two producing regions of Figure 1, and the 40-acre vineyard would require 660 end posts (16.5 posts per acre). The wooden line posts are positioned every three vines (24 feet between line posts), starting 24 feet from an end post. The

**Table 1. Input Quantities Used for Trellis Systems**

| | SCBC (8 by 8 spacing) | SCBC (20 by 9 spacing) | VSP (8 by 8 spacing) | Unit |
|---|---|---|---|---|
| Line posts* | 218.0 | 242.0 | 680.0 | acre |
| Treated end posts (6in x 8ft) | 16.5 | 14.6 | 16.5 | acre |
| Anchors to stabilize end posts | 16.5 | 14.6 | 16.5 | acre |
| # 9 wire HT (tie off end posts) | 236.0 | 209.0 | 236.0 | ft/acre |
| # 9 wire HT (cordon wire) | 5,445.0 | 4,840.0 | 5,445.0 | ft/acre |
| # 12.5 wire HT (fixed catch wire) | 5,445.0 | 4,840.0 | 5,445.0 | ft/acre |
| # 13 wire (VSP moveable catch wires) | - | - | 32,670.0 | ft/acre |
| Wire clips | - | - | 1,360.0 | acre |
| Growth tubes | 680.0 | 242.0 | 680.0 | acre |

*Wooden line posts (3 in. by 8 ft.) are used for the SCBC trellis and 8 ft metal line posts are used for the VSP trellis.

**Table 2. Labor Assumptions for Trellis Installation**

| Task | No. of Workers | Time/ Activity | Unit | Total Time in Hours | | |
|---|---|---|---|---|---|---|
| | | | | SCBC (8 by 8 spacing) | SCBC (20 by 9 spacing) | VSP (8 by 8 spacing) |
| Mark post locations | | | | 1.00 | 1.00 | 1.00 |
| Distribute posts | 2 | | | 4.00 | 4.00 | 4.00 |
| Drive line posts | 2 | 3 | min/post | 21.80 | 24.20 | 68.00 |
| Auger holes for end post | 2 | 5 | min/hole | 2.75 | 2.43 | 2.75 |
| Set end posts | 2 | 6 | min/post | 3.30 | 2.92 | 3.30 |
| Install end post anchors | 1 | 5 | min/post | 1.38 | 1.22 | 1.38 |
| String, attach & tighten wires | | | | 15.00 | 15.00 | 30.00 |
| Total /acre | | | | 49.23 | 50.77 | 110.43 |

**Table 3. Trellis System Establishment Costs and Annual Fixed Costs per Acre.**

| | | New cost ($) | | | Amortization Charge ($) | | |
|---|---|---|---|---|---|---|---|
| Item | Expected years of life | SCBC (8 by 8 spacing) | SCBC (20 by 9 spacing) | VSP (8 by 8 spacing) | SCBC (8 by 8 spacing) | SCBC (20 by 9 spacing) | VSP (8 by 8 spacing) |
| Line posts | 30 | 46,652.00 | 51,788.00 | 122,400.00 | 3,498.72 | 3,883.90 | 9,179.53 |
| End posts | 30 | 8,118.00 | 7,183.20 | 8,118.00 | 608.82 | 538.71 | 608.82 |
| Anchors | 30 | 3,927.00 | 3,474.80 | 3,927.00 | 294.51 | 260.60 | 294.51 |
| # 9 wire HT (tie off end posts) | 30 | 399.69 | 353.96 | 399.69 | 29.98 | 26.55 | 29.98 |
| # 9 wire HT (cordon wire) | 30 | 9,221.65 | 8,197.02 | 9,221.65 | 691.59 | 614.75 | 691.59 |
| # 12.5 wire HT (fixed catch wire) | 30 | 3,590.98 | 3,191.98 | 3,590.98 | 269.31 | 239.39 | 1,753.52 |
| # 13 wire (VSP moveable catch wires) | 30 | - | - | 23,381.47 | | | 244.79 |
| Wire clips | 30 | - | - | 3,264.00 | - | - | 244.79 |
| Installation | 30 | 16,323.01 | 16,835.33 | 36,616.93 | 1,224.16 | 1,262.58 | 2,746.13 |
| Totals | | 88,232.33 | 91,024.30 | 210,919.72 | 6,617.08 | 6,826.47 | 15,793.64 |
| **Per Acre Fixed Costs of Trellis System** | | | | | | | |
| Per acre amortization charge | | | | | 165.43 | 170.66 | 394.84 |
| Taxes | | | | | 5.51 | 5.69 | 13.18 |
| Insurance | | | | | 6.62 | 6.83 | 15.82 |
| Totals | | | | | 177.56 | 183.18 | 423.84 |

total number of line posts required is 8,720 (218 per acre). One metal line post every 8 feet is assumed for the VSP system for a total of 680 line posts per acre. The SCBC system with the 20 foot by 9 foot spacing, used for muscadines, requires fewer end posts as there would be only 146 rows in each of the two producing regions of Figure 1. In total, 584 end posts (14.6 per acre) are required. On this 20 by 9 spacing, line posts are positioned every 20 feet instead of every 24 feet in order to provide adequate support for muscadine vines. In total 242 line posts are required per acre.

The amount of wire needed for the trellis system is calculated as follows. There are 43,560 sq ft in an acre. Dividing this number by 8 feet (space between rows), except in muscadines where the distance between rows is 9 feet, provides the length of wire to be used per strand (or line of wire) per acre. This length is the same regardless of the gauge of the wire. The variation in costs for wires of different gauges resides in the weight of the wires, where stronger or thicker wires (the ones with a lower gauge number) have fewer feet per pound of wire, thus requiring a larger number of rolls per acre.

In these budgets it is assumed that growth tubes are used during the year of planting for all varieties. Growth tubes are useful in protecting young vines from herbicide damage and prevents vertebrate pests such as deer or rabbits feeding on the vines. It is assumed that growth tubes will negate the need for training stakes.

Assumptions about the labor required to build the trellis systems are outlined in Table 2. The accuracy of these assumptions depends on soil conditions; in particular, the times reported may understate that required for sites that are particularly rocky and may overstate time required for sites generally free of large rocks below the soil surface.

Annual fixed costs for the trellis system consist of an annualized amortization charge, and annual expenses for taxes and insurance. The amortization charge is calculated by amortizing the new cost, including installation labor (See Table 3), over the 30-year life of the vineyard. Tax and insurance expenses are estimated by:

Tax or insurance expense = *[(PP + SV)÷ 2] x (tax rate or insurance rate)*.

PP = Purchase Price

SV = Salvage value

A salvage value of zero is assumed for trellis structures at the end of the vineyard's useful life. This method will give an accurate estimate of the average tax and insurance expense over the life of the vineyard but will overstate (understate) tax and insurance costs for the early (latter) part of the planning horizon.

Variable costs of the trellis system consist of annual repair and maintainance expenses. Variable costs are computed as the new cost including installation from Table 3, multiplied by a repair and maintenance coefficient of 0.007.

**Irrigation System**

Rainfall in Arkansas is not sufficient on average for producing optimal grape yields. Irrigation increases both the quantity and the quality of grapes and reduces the variability between harvests. Requirements will vary depending on the site and the soil's texture and moisture retention capabilities. The irrigation-system setup has the capacity to apply from 0 to 15 acre-inches of water. Ten acre-inches are adequate for the typical situation during an average year, and this number is used as the irrigation rate for variable cost computations reported in the budgets. However, some years may require more or less, and it is important to specify an irrigation system that can accommodate up to 15 acre-inches for dry years. Water acquisition is assumed to be from an on-farm or near-by surface source, such as a pond or spring. If a grower must get water from a well, costs would have to reflect additional expenses. For a 40-acre drip irrigation system, the following assumptions were made:

1. A diesel, two cycle, 80 cubic in engine (pump or power source).
2. Fertigation system: complete 200 gallon duplex chemigation system, 3 phase.
3. Pumping head is 80 psi with a water flow of 300 gal/min.
4. Pump efficiency is rated at 60% with a 14-year life expectancy for the pumping system with zero salvage value.
5. The irrigation laterals are suspended 18 in above the ground by #12.5 wire, with clips every 4 feet.

The irrigation system setup is shown in Figure 1. It consists of a power set (pump), which lies in one side of the field (where the water source is), and is directly connected to the main headers. The main headers are placed in the field, one line directly out of the pump and across the full width of the field, cutting across the exact middle of the trellis line; in every trellis line, the main header is raised to the correspondent height (18 in) by a t-tube and, from there, the in-line emitters lie in the same direction as the trellis. From the t-tube, 330 feet of in-line emitters extend to each side. Another main header line runs from the pump, along the side of the field, and then into the field through the middle of the other trellis system set. Information for materials and costs for the irrigation system were obtained from local suppliers (Scates, 2003; Paige, 2003). The irrigation setup for muscadines, with 9 feet between rows, requires less tubing and other inputs per acre.

The amount of tubing was calculated as follows:

1. Main headers: calculated linearly from the pump to the end of each strand.
2. In-line emitters: as in the trellis system, to calculate the amount of wire needed, 43,560 sq ft (square footage per acre) was divided by 8 feet or 9 feet (depending on the type of grape), thus obtaining the linear footage of pipes and wire needed for the system.

**Table 4. Irrigation System Establishment and Annual Fixed Costs per Acre**

| | | SCBC (20 by 9 spacing) | | SCBC and VSP (8 by 8 spacing) | |
|---|---|---|---|---|---|
| Item | Expected Years of Life | Annual new cost($) | Annual Amortization Charge | Annual new cost($) | Annual Amortization Charge |
| Power set | 14 | 8,550.00 | 937.01 | 8,550.00 | 937.01 |
| Fertigation system | 14 | 4,140.00 | 453.71 | 4,140.00 | 453.71 |
| Pipe: main headers | 10 | 1,531.80 | 211.09 | 1,531.80 | 211.09 |
| Pipe: in-line emitters | 10 | 48,400.00 | 6,669.79 | 54,450.00 | 7,503.52 |
| Filtration system | 20 | 1,443.75 | 128.96 | 1,443.75 | 128.96 |
| Tensiometer 24 in (10) | 5 | 662.50 | 158.56 | 662.50 | 158.56 |
| Tensiometer service kit | 5 | 36.00 | 8.62 | 36.00 | 8.62 |
| Wire | 30 | 3,191.98 | 239.39 | 3,590.98 | 269.31 |
| Clips | 10 | 1,936.00 | 266.79 | 2,177.60 | 300.09 |
| Totals | | 69,892.03 | 9,073.92 | 76,582.63 | 9,970.86 |
| **Annual Fixed Costs Irrigation System ($ per acre)** | | | | | |
| Per acre amortization charge | | | 226.85 | | 249.27 |
| Taxes | | | 4.37 | | 4.79 |
| Insurance | | | 5.24 | | 5.74 |
| Totals | | | 236.46 | | 259.80 |

Variable irrigation costs outlined in Table 5 assume an application rate of 10 acre-inches and include repair and maintenance costs on the irrigation equipment, irrigation labor (calculated at 0.134 hours per acre-inch), and fuel costs for the pump. The pump described above can move 18,000 gallons of water per hour. Assuming an evaporation multiplier of 1.16 and given 27,154 gallons in one acre-inch, the pump needs to operate 699 hours per year to provide 10 acre-inches to the entire 40 acres. Fuel costs per hour are based on the assumed diesel price of $1.37 per gallon and the horsepower and efficiency rating of the pump.

**Machinery**

Grape production requires machinery that is specific to the activity, besides the machinery that is commonly used for field production of any other crop. For that reason, the approach to measuring machinery fixed costs used in the budgets is to allocate the entire annual fixed cost to the grape production enterprise, instead of allocating fixed costs according to hours of machinery operations, as is commonly done in enterprise budgets for field crops. Machinery operations that occur infrequently or use general purpose equipment, such as those associated with preparing the field for planting, are assumed to be done on a custom basis.

**Table 5. Per Acre Variable Costs for Irrigation (Assuming 10 Acre Inches per Year)**

| Item | Cost of New Equipment ($) | Maintenance and Repair Coefficients | Cost per hour of Operation ($) | Hours per Year | Annual Cost ($) |
|---|---|---|---|---|---|
| Pump set | 8,550.00 | 0.07 | | | 14.96 |
| Distribution pipes | 1,531.80 | 0.005 | | | 0.19 |
| Fuel | | | 1.70 | 699.37 | 29.70 |
| Filter | 1,443.75 | 0.1 | | | 3.61 |
| Irrigation labor | | | 8.29 | 53.60 | 11.11 |
| Total variable cost per acre | | | | | 59.57 |

Fixed costs for machinery consist of an annual capital recovery charge, taxes, and insurance. Tax and insurance costs are computed in the same manner as the trellis and irrigation systems above. The following formula is used to compute capital recovery charges:

Annual Capital Recovery Charge = *[(PP- SV) x (CRF)] + (SV x R)*

PP: Purchase price
SV: Salvage value
CRF: Capital recovery factor.
R: Interest rate

The capital recovery factor is the amount required to cover the annual principal and interest on one dollar paid off over the useful life of the machine. The price of the tractor includes the price of a safety cab used for the protection of the operator during the spraying of chemicals. The size of the tractor, 80 HP, takes into account the possibility of a future acquisition of a mechanical harvester.

Fixed costs for machinery are reported in Table 6. Some of the implements listed in Table 6 are specific to certain varieties. Specifically, the grape hoe and summer pruner are used only in the production of *V. vinifera* grapes. The transplanter is not used for *V. vinifera* grapes, as these grapes are assumed to be hand planted.

The transplanter, grape hoe, and vineyard disk are used only for operations that occur during the establishment years of the vineyard. Although it would be ideal to complete these operations on a custom basis, it is likely to be difficult to find custom operators with these implements. It is assumed for budget purposes that the producer purchases each of these implements, and that each has a 30 year useful life. Otherwise, the useful life for machinery follows data presented by the American Society of Agricultural Engineers (ASAE, 2002).

Variable costs for the machinery, presented in Table 7, include the labor of the machine operator, fuel consumption, lubrication, and an allowance for repair and maintenance. An efficiency rate measuring the hours required to cover one acre as estimated for each implement as follows:

$$\text{Hours per acre} = \left(\frac{S \times W \times E}{8.25}\right)^{-1}$$

S: machine speed (mph)
W: effective width (feet)
E: efficiency

After obtaining this efficiency estimate the variable cost of each machinery operation was computed as follows:

- Fuel: Diesel consumption for the tractor was estimated according to ASAE norms,

  Diesel per hour = (0.044) x (Max. Tractor HP).

  For an 80 HP, the diesel consumption was estimated to be 3.52 gallons per hour.

- Lubrication: According to the ASAE, surveys indicate that lubrication costs average about 15% of fuel costs. This estimate was used in these budgets.

- Repair and Maintenance: repair and maintenance costs vary widely from one geographic region to another because of soil type, terrain, and climate. For purposes of the budgets, ASAE averages were used for the estimation of repair and maintenance. Repair and maintenance percentages for each machine were estimated in dollars per hour over the total useful life of the equipment and then converted to dollars per acre.

$$\text{Repair and maintenance} = \frac{LP \times TRP}{Life}$$

LP: List price
TRP: Total accumulated repairs as a % of list price
Life: Hours of use over machine's useful life

**Table 6. Machinery Fixed Costs**

| Machinery and Equipment | Purchase Price | Years Owned | Salvage Value | Capital Recovery Factor | Annual Recovery | Insurance | Taxes | Total Fixed Costs | Total Fixed Costs Per Acre |
|---|---|---|---|---|---|---|---|---|---|
| Tractor (80HP) | 36,212.00 | 10.00 | 10,696.45 | 0.14 | 4,187.37 | 140.73 | 117.27 | 4,445.36 | 111.13 |
| Disk | 4,727.00 | 30.00 | 72.62 | 0.07 | 353.64 | 14.40 | 12.00 | 380.03 | 9.50 |
| Transplanter | 2,000.00 | 30.00 | 30.72 | 0.07 | 149.62 | 6.09 | 5.08 | 160.79 | 4.02 |
| Tractormount sprayer | 1,200.00 | 8.00 | 270.94 | 0.16 | 168.41 | 4.41 | 3.68 | 176.50 | 4.41 |
| Gun sprayer | 175.00 | 5.00 | 57.00 | 0.24 | 31.82 | 0.70 | 0.58 | 33.09 | 0.83 |
| Bush hog | 1,100.00 | 10.00 | 194.53 | 0.14 | 136.94 | 3.88 | 3.24 | 144.06 | 3.60 |
| Summer pruner | 1,500.00 | 10.00 | 265.26 | 0.14 | 186.73 | 5.30 | 4.41 | 196.44 | 4.91 |
| Vineyard sprayer | 17,736.00 | 8.00 | 4,004.54 | 0.16 | 2,489.14 | 65.22 | 54.35 | 2,608.71 | 65.22 |
| Grape hoe | 4,200.00 | 30.00 | 64.52 | 0.07 | 314.21 | 12.79 | 10.66 | 337.66 | 8.44 |
| Trailer 6 x 10 ft | 2,000.00 | 10.00 | 353.68 | 0.14 | 248.98 | 7.06 | 5.88 | 261.93 | 6.55 |

**Table 7. Machinery Variable Costs**

| Item | Width (ft) | Field Efficiency | Avg. speed (mph) | Performance rates (hr/ac) | Labor (hrs/acre) | Estimated life (hrs) | Life R&M cost (% new cost) | Total repair costs ($/hr) | Fuel ($/hr) | Lube ($/hr) | Var. cost ($/acre) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tractor (80HP) | NA | 0.88 | 8.0 | | | 12,000 | 100 | 3.02 | 4.82 | 0.72 | |
| Tandem disk | 5 | 0.80 | 4.0 | 0.516 | 0.619 | 2,000 | 60 | 1.42 | | | 11.03 |
| Transplanter* | 4 | 0.80 | 2.0 | 1.289 | 1.547 | 1,500 | 70 | 0.93 | | | 52.58 |
| Tractormount spray | 6 | 0.65 | 5.0 | 0.423 | 0.508 | 1,500 | 70 | 0.56 | | | 8.68 |
| Gun sprayer | 6 | 1.00 | 5.0 | 0.275 | 0.330 | 2,000 | 70 | 0.06 | | | 5.51 |
| Bush hog | 5 | 0.85 | 7.0 | 0.277 | 0.333 | 2,000 | 70 | 0.39 | | | 5.64 |
| Summer pruner | 4 | 0.85 | 7.0 | 0.347 | 0.416 | 2,000 | 70 | 0.53 | | | 7.10 |
| Vineyard sprayer | 8 | 0.75 | 7.5 | 0.183 | 0.220 | 2,000 | 70 | 6.21 | | | 4.80 |
| Grape hoe | 9 | 0.50 | 3.0 | 0.611 | 0.733 | 2,000 | 70 | 1.47 | | | 13.10 |
| Trailer 6 x 10 ft | 6 | 0.90 | 4.5 | 0.340 | 0.407 | 2,000 | 70 | 0.70 | | | 7.01 |

*Variable cost for transplanter includes one machine operator and 2 hourly workers

- Labor: Because of the time required to lubricate and service machines, as well as time delays in getting to and from the field, the actual man hours of labor usually exceed actual field time by 10 to 20 percent (Boehlje & Eidman, 1984). Labor for each machinery operation was estimated to be an extra 20 percent of the field time.

**Annual Pre-harvest Costs and Budget Calculations**

Sequences of operations for each of the 6 varieties of wine or juice grapes are presented in Appendix B. During the year prior to planting (year 0 in appendix tables B1-B3), the sequence of operations involves spraying a broad spectrum herbicide followed by sub-soiling. It is assumed for budgetary purposes that custom work is used for both of these operations. Operating costs per acre for the year prior to planting were estimated to be $36.50 per acre and are the same regardless of variety. It is assumed that after planting the grapes in the spring of year one, the trellis and irrigation systems are put in place. Hence, the producer incurs annual fixed costs for trellises, irrigation, and machinery during year one and every year thereafter. It is assumed that preharvest operating sequences for mature vineyards begin in year three and continue through the remaining life of the vineyard.

Four grape types -- French American Hybrids, American Hybrids, *V. labrusca*, and *V. aestivalis* -- involve sequences that are very similar. That is, the materials and structures, field operations, hours of non-harvest labor, and applications of chemicals and fertilizers would be almost identical among varieties within each of these four types. There are differences, however, in the cost of new grape plants, and there is some variation in fungicide applications among these varieties, resulting in slightly different spray schedules (see Table B1 of Appendix B).

Production of muscadines involves a spray schedule that incurs lower costs than the production of other varieties. Because muscadines are spaced 9 feet between rows and 20 feet between vines, pruning and training passes take less time, resulting in lower manual labor costs. After planting, a sod is established more quickly in muscadines than in the other varieties. Muscadines have a shallow root system that can quickly spread into the row middles. Disking passes used on the other varieties during the year of planting can damage these roots and should be avoided in muscadine production. Sequences of operations for *V. vinifera* varieties differ markedly in that these grapes are assumed to be trained to a VSP trellis system. This requires additional operations such as wire lifts, shoot positioning, and trimming of shoots at the top of the canopy in mature vineyards. Furthermore, unlike the other varieties covered by these budgets, *V. vinifera* varieties are grafted, and additional operations are required during establishment years to protect the graft union from cold damage. Finally, *V. vinifera* varieties require a spray schedule that is considerably more rigorous and costly than any of the other varieties.

Table 8 presents a budget for Chambourcin and is used as an example to illustrate budget calculations. Costs incurred during establishment years (years 0 to 3) are totaled and carried over as cumulative costs. In the example budget, cumulative costs total $4,001 by the end of year three. This figure is amortized over the remaining life of the vineyard (27 years) and the amortized establishment charge of $312 is treated as a fixed cost in the budget for mature vineyards. For budget purposes, it is assumed that the first harvestable yield occurs in year 3 and that full production is achieved by year 4. To avoid damage to young vines, the first harvestable yield is harvested by hand with subsequent harvests being done mechanically on a custom basis. Because of their high quality, *V. vinifera* grapes are assumed to be hand-harvested throughout the life of the vineyard. Harvest cost assumptions include hand-harvesting at a piece rate of $100 per ton, custom machine harvesting at a rate of $40 per ton, and hauling costs of $15 per ton. In establishment years with no har-

**Table 8. Vineyard Budget for Chambourcin: Costs and Returns per Acre**

| | Year 0 | Year 1 | Year 2 | Year 3 | Year 4-30 |
|---|---|---|---|---|---|
| *Revenue* | | | | | |
| Yield (tons) | | | | 4.00 | 6.30 |
| Market Price ($/ton) | | | | 850.00 | 850.00 |
| Total Revenue | | | | 3,400.00 | 5,355.00 |
| | | | | | |
| *Variable Costs* | | | | | |
| Preharvest Operating Costs | 36.50 | 2,274.43 | 570.33 | 1,256.14 | 1,256.14 |
| Variable Irrigation Costs | - | 59.57 | 59.57 | 59.57 | 59.57 |
| Trellis System Maintainance | - | 15.44 | 15.44 | 15.44 | 15.44 |
| Harvest Costs | - | - | - | 460.00 | 346.50 |
| Interest on Operating Capital | 3.10 | 105.98 | 22.52 | 26.42 | 26.42 |
| Total Variable Costs | 39.60 | 2,455.42 | 667.86 | 1,817.57 | 1,704.07 |
| Returns Above Variable Costs | (39.60) | (2,455.42) | (667.86) | 1,582.43 | 3,650.93 |
| | | | | | |
| *Fixed Costs* | | | | | |
| Trellis System | | 177.56 | 177.56 | 177.56 | 177.56 |
| Irrigation System | | 259.80 | 259.80 | 259.80 | 259.80 |
| Machinery | | 205.26 | 205.26 | 205.26 | 205.26 |
| Amortized Establishment Cost | | | | | 312.05 |
| Total Fixed Costs | - | 642.62 | 642.62 | 642.62 | 954.67 |
| | | | | | |
| Total Costs | 39.60 | 3,098.04 | 1,310.48 | 2,460.19 | 2,658.74 |
| Net Returns | (39.60) | (3,098.04) | (1,310.48) | 939.81 | 2,696.26 |
| Interest on Cumulative Costs | | 2.50 | 197.83 | 292.85 | |
| Cumulative Costs | 39.60 | 3,140.14 | 4,648.45 | 4,001.49 | |
| Ammortized Annual Establishment Charge | | | | 312.05 | |

vestable yield, interest on operating capital is charged from the time the operation was performed through December 31. For the subsequent years, operating interest was charged from the time the operation was performed to an average harvest day, specific to the varietal group in question.

## Budget Results

Net returns, breakeven points, and shutdown price are presented in Table 9. The net returns figure reflects returns above all costs specified in the budgets and can be considered returns to land, management, and overhead costs not explicitly entered into the budgets. Break-even points include:

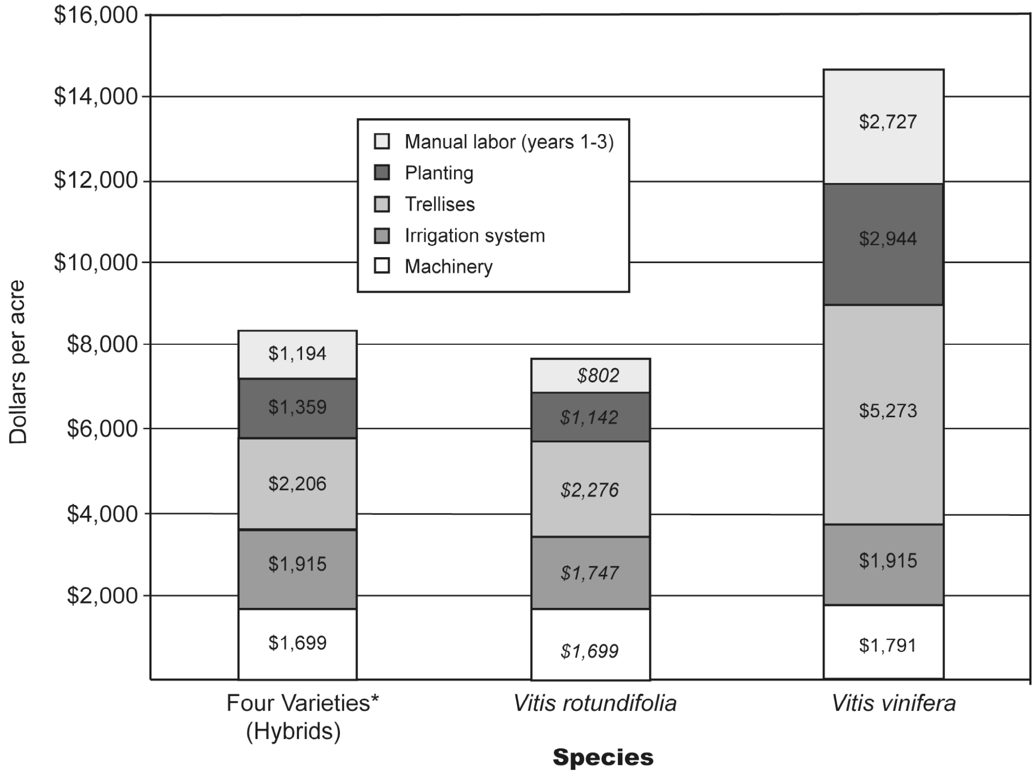
- Break-even price: the price at which net returns equal zero assuming the mature vineyard yield as reported in the first column of Table 9.
- Break-even yield: the yield at which net returns equal zero assuming the price as reported the second column of Table 9.

In interpreting any of these results it is important to keep in mind the large fixed costs represented by investments in a trellis system, an irrigation system, and specialized machinery. The fixed cost components of a vineyard are probably subject to considerable variability from producer to producer and across different geographic regions of the state. It may be possible for some of these costs to be saved, for example, by opting to purchase used equipment. However, it is important to note that in some cases fixed costs reported here will understate those faced in an actual situation. For example, deer and/or birds can severely impact yields. If these pests are a problem, structures and materials will be needed to control them. Figure 2 presents a break-down of the major capital expenditures required to establish a vineyard. The largest capital expenditures are represented by the trellis and irriga-

**Table 9. Per Acre Returns and Break Even Points for Arkansas Grape Varieties**

| | Baseline Assumptions | | Returns | | Break-even and Shutdown Points | | |
|---|---|---|---|---|---|---|---|
| | Mature Yield tons/acr | Market Price $/ton | Return Above Variable Cost | Net Returns | Break Even Price | Break Even Yield | Shut Down Price |
| **American Hybrids** | | | | | | | |
| Cayuga White (White) | 6.50 | 475.00 | 1,372.43 | 275.52 | 432.61 | 5.92 | 263.86 |
| Chardonel | 6.00 | 700.00 | 2,512.43 | 1,485.71 | 452.38 | 3.88 | 281.26 |
| Traminette | 6.00 | 700.00 | 2,512.43 | 1,485.71 | 452.38 | 3.88 | 281.26 |
| ***Vitis aestivalis*** | | | | | | | |
| Cynthiana | 4.00 | 850.00 | 2,173.29 | 1,163.23 | 559.19 | 2.63 | 306.68 |
| **French-American Hybrids** | | | | | | | |
| Chambourcin (Red) | 6.30 | 850.00 | 3,650.93 | 2,696.26 | 422.02 | 3.13 | 270.49 |
| Seyval (White) | 5.40 | 450.00 | 775.43 | (304.01) | 506.30 | 6.08 | 306.40 |
| Vidal (White) | 6.00 | 510.00 | 1,372.43 | 311.70 | 458.05 | 5.39 | 281.26 |
| Vignoles(White) | 4.50 | 725.00 | 1,657.43 | 616.20 | 588.07 | 3.65 | 356.68 |
| ***Vitis labruscana*** | | | | | | | |
| Catawba (Pink) | 6.00 | 450.00 | 1,099.35 | 70.71 | 438.22 | 5.84 | 266.78 |
| Concord (Red) | 8.00 | 300.00 | 689.35 | (371.65) | 346.46 | 9.24 | 213.83 |
| Delaware (Pink or White) | 5.40 | 400.00 | 592.35 | (451.88) | 483.68 | 6.53 | 290.31 |
| Niagara (White) | 7.20 | 375.00 | 1,033.35 | 1.59 | 374.78 | 7.20 | 231.48 |
| Sunbelt | 8.00 | 400.00 | 1,489.35 | 467.34 | 341.58 | 6.83 | 213.83 |
| ***Vitis rotundifolia*** | | | | | | | |
| Carlos | 8.00 | 400.00 | 1,360.13 | 425.03 | 346.87 | 6.94 | 229.98 |
| Noble | 8.00 | 400.00 | 1,360.13 | 425.03 | 346.87 | 6.94 | 229.98 |
| ***Vitis vinifera*** | | | | | | | |
| Cabernet Franc (Red) | 5.00 | 1,400.00 | 3,992.16 | 2,674.39 | 865.12 | 3.09 | 601.57 |
| Cabernet Sauvignon (Red) | 5.00 | 1,600.00 | 4,992.16 | 3,806.19 | 838.76 | 2.62 | 601.57 |
| Chardonnay (White) | 4.50 | 1,100.00 | 1,999.66 | 444.57 | 1,001.21 | 4.10 | 655.63 |
| Merlot (Red) | 5.00 | 1,500.00 | 4,492.16 | 3,240.29 | 851.94 | 2.84 | 601.57 |
| Viognier (White) | 5.00 | 1,200.00 | 2,992.16 | 1,542.60 | 891.48 | 3.71 | 601.57 |
| White Riesling (White) | 5.40 | 1,000.00 | 2,346.16 | 868.99 | 839.08 | 4.53 | 565.53 |

**Figure 2. Major Capital Expenditures for Vineyard Establishment.**




*Four varieties include American Hybrids, French-American Hybrids, *V. aestivalis*, and *V. labruscana*.
Planting includes the cost of vines, machinery, and labor required for planting.

tion systems, followed by machinery purchases and planting costs. Planting costs for *V. vinifera* grapes are considerably larger than the other varieties because these grapes are hand planted and require substantially more labor than varieties using a transplanter.

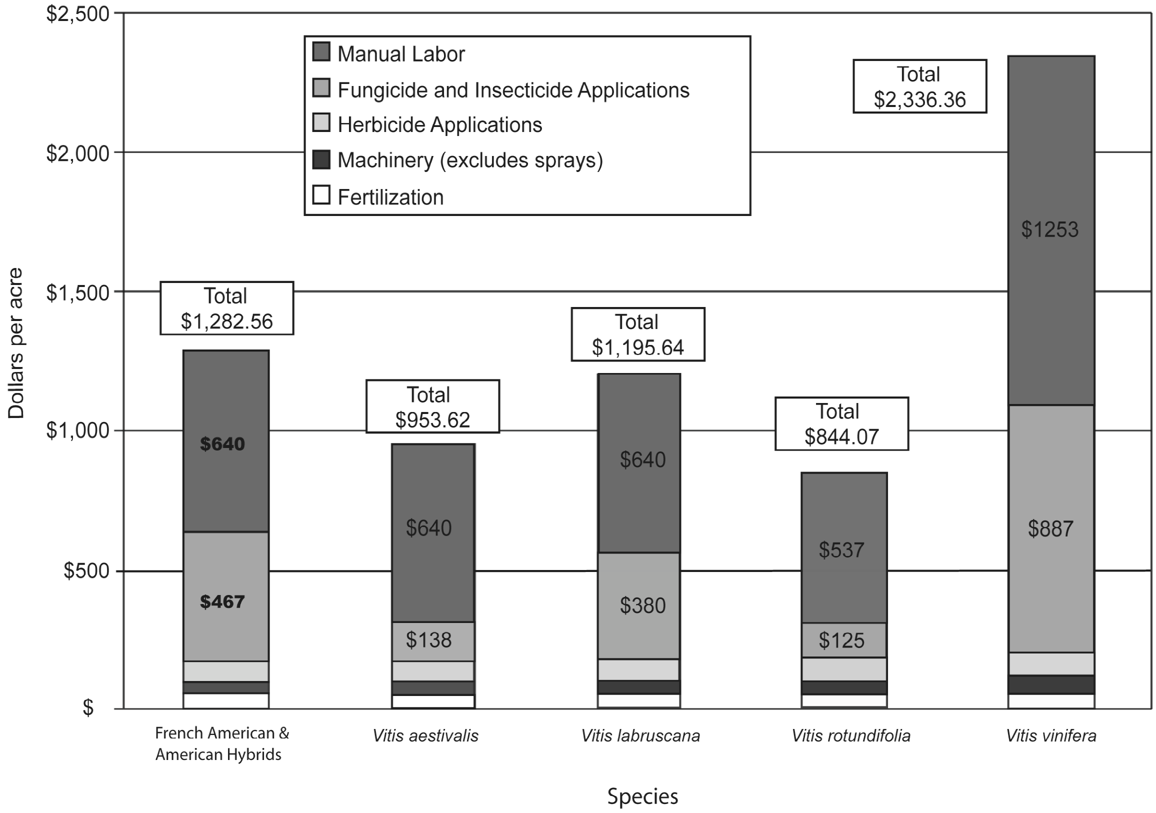
The shutdown prices reported in Table 9 do not depend on fixed cost calculations and reflect the price at which revenues exactly equal variable costs. The interpretation of the shutdown price is that a rational producer would cease production, i.e., go out of business, if prices fell below the shutdown point. At prices above the shutdown price, it is less costly to remain in business than to cease operations, even if net returns are negative. The reason is that for prices above the shutdown price, the vineyard is generating revenues that can at least partially offset fixed costs. Figure 3 presents a breakdown of ongoing operating costs for an established vineyard. Regardless of variety, labor accounts for at least half of all pre-harvest operating costs.

An apparent conclusion from Table 9 is that *V. vinifera* varieties are among the most profitable. This conclusion requires some qualifications and should be viewed with a degree of caution. First, as noted earlier, these varieties are suited only to some of the best sites in the state, and even though apparently profitable, they may not be a feasible choice for many growers. Secondly, they require the most input-intensive operations sequence and highest level of management. Finally, and perhaps most importantly, there is limited experience in commercial production of *V. vinifera* varieties in Arkansas. As a result, price and yield projections in columns 1 and 2 of Table 9 must be viewed with caution, and the more important numbers for planning purposes are probably break-even prices and yields.

Based on current price and yield estimates other promising varieties, with estimated net returns in excess of $425 per acre, include Chardonel, Traminette, Cynthiana, Chambourcin, Vignoles, Sunbelt, and the muscadine varieties Carlos and Noble. One or more of these varieties can be successfully grown in most regions of the state.

Among the varieties presented in Table 9, *V. labruscana* varieties show the lowest level of profitability as a group -- with one exception being the Sunbelt variety. It is unlikely that returns will justify increases in acreage of these varieties. However, current price estimates exceed shutdown prices by a large margin (current price is 138 percent of the shutdown price for the least profitable Delaware variety) and indicate that acreage already committed to these varieties will likely remain in operation at current prices as long as existing vineyards remain productive.

**Figure 3. Breakdown of Pre-harvest Operating Costs for Mature Vineyards.[a]**




a. Totals include interest on operating capital.

## Discussion

Site, soil, and climatic conditions vary considerably across Arkansas and are the predominant considerations in selecting a grape variety. The budgets presented here suggest that one or more varieties can be profitably grown in most regions of the state. *V. rotundifolia* grapes, in particular, are suited to the warmer and more humid climates characteristic of the southern parts of Arkansas. These grapes provide reasonable returns and may represent a promising new crop for regions of the state that have not traditionally been involved in commercial grape production. Furthermore, muscadines are easier to grow than other varieties and are thus attractive for producers that are new to grape production. In parts of the state with more temperate climates, *V. aestivalis*, Sunbelt, and several hybrid varieties provide good profit potential and have production requirements requiring a moderate degree of management intensity. *V. aestivalis* vineyards are less susceptible to many diseases and require a fungicide spray program that is less complex than that required by the hybrid or *V. labruscana* varieties. However, proper management of *V. aestivalis* vineyards is crucial in order to obtain the yields assumed in these budgets. It is not uncommon for commercial vineyards in Arkansas to yield tonnages at or below the breakeven point reported in this analysis. *V. vinifera* varieties offer the largest profit potential but require the most complex management program. Even if site, soil, and climatic conditions are suited to these varieties, the intensive management requirements, considerably larger up-front investment, and high ongoing costs of vineyard operations represent substantial barriers, especially for producers new to grape production.

One conclusion from the budgets that warrants further attention is the substantial capital investments required to get into the production of wine or juice grapes. This investment is large relative to many alternative crops grown in the state. Grape production involves a long-term commitment, and much of the investment cannot be recovered if a producer decides to leave the business. If prices do not materialize, the spread between current market prices and shutdown prices shows the potential for operating at an economic loss, possibly for as long as the vineyard is productive. To illustrate this point consider a producer who establishes a Chambourcin vineyard. At the estimated current price of $850 per ton, the budget analysis presented here suggests Chambourcin is a particularly attractive variety both from its profit potential and from its moderate degree of management intensity, which falls somewhere between the extremes of *V. rotundifolia* and *V. vinifera* varieties. Once the producer establishes this vineyard, he incurs an economic loss if the price of Chambourcin falls below the break-even price of $417 per ton. At the breakeven price, the producer gains a net return of $0 per acre. However, if the producer shuts down production when the price is $417 per ton, the net return would decrease from $0 to a $925 per acre loss. The fixed costs of a Chambourcin vineyard are $925 per acre and the producer incurs these fixed costs regardless of whether production continues. This producer would always incur smaller losses (larger net returns) by remaining in business whenever the price of Chambourcin is above the shutdown price of $270 per ton. At this juncture, it is important to distinguish between an "economic loss" and an "accounting loss". At prices below the breakeven point, the producer incurs an economic loss because money tied up in the vineyard operation is earning less than it could in an alternative investment opportunity. The economic loss occurs regardless of whether the vineyard operation is self-financed or financed through a lender. However, there are many situations in which the producer could generate a cash flow sufficient to cover ongoing obligations and/or could show a positive net income on accounting statements or income tax forms, even if prices are below the breakeven point.

The concern that logically follows from the above discussion is that once a vineyard is established, a buyer could substantially lower the price and still keep a grower in business and providing a steady supply of grapes. In theory, the buyer would only need to offer prices above the shutdown point. This concern is less important if there are a large number of alternative market outlets for grapes. However, grapes are perishable and timing of harvest is important to quality and yield. The number of buyers that can be found on short notice will, in most cases, be small. Fortunately, most buyers recognize that opportunistic behavior usually does not make long-term business sense, and that such behavior will compromise their future ability to source the needed quantity and quality of grapes, but the concern of being held-up on price cannot be ignored. A vineyard is in production for a long time, and the same type of problem can occur if the winery or juice processor to whom the grower usually sells goes out of business. An alternative buyer may be unwilling or unable to provide the same price level, and the grower could be placed in a situation of economic loss.

A contractual relationship with a buyer can do much to alleviate the risk of hold-up. A contract with a winery or processor should be in writing and should specify the amount and type of grapes to be delivered, what constitutes acceptable quality, and a price, or at least a means of determining a price, at harvest time. Ideally, a grower would have a contracted price for the first few years of vineyard establishment with later years being tied to market prices. Such an arrangement would help to guarantee a return during establishment years when cash flow is likely to be tightest but would allow flexibility in that later years would follow market trends. Another recommendation to limit the potential for hold-up or the loss of an intended buyer is choose varieties with traits desirable to multiple wineries, juice processors, or other market outlets in the region to reduce reliance on a single buyer. In selecting varieties, adaptability to different market outlets may be a more important to the long-term success of the operation than profit potential forecasted prior to vineyard establishment.

Due in part to the potential for hold-up on price, and also to coordination and quality control problems, many, if not most, vineyard operations are vertical extensions of a wine or juice processing establishment; in other words, the vineyard and processing operations are under common ownership. The budgets reported here likely overstate some costs that would result from an existing vineyard operation expanding into more acreage because it is possible that some of the fixed inputs already in place, especially machinery, could be used to meet the needs of the expansion. While efforts have been made to accurately reflect the costs associated with grape production in Arkansas, any actual operation will likely differ in important ways from the assumptions outlined in these budgets, which are intended to be examples that aid in the development of sound business plans and are not intended to be substitutes for business plans themselves.

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# Appendix A:
# Prices and Rates Used for Budget Computations

**Table A1. Rates for Custom Machinery Operations**

| Operation | Unit | Price |
|---|---|---|
| Custom subsoiling | Acre | $ 12.00 |
| Custom moldboard plowing | Acre | 12.00 |
| Custom spike harrowing | Acre | 6.00 |
| Custom herbicide spraying | Acre | 5.00 |
| Custom hand picking | Ton | 100.00 |
| Custom machine harvesting | Ton | 40.00 |
| Custom hauling | Ton | 15.00 |
| Custom lime application | Acre | 4.00 |
| Custom drilling of cover crop | Acre | 5.75 |

**Table A2. Prices for Grape Plants and Cover Crop Seed**

| Input | Unit | Price |
|---|---|---|
| Grape plants (*Vitis vinifera* , grafted) | Each | $ 3.50 |
| Grape plants (French-American hybrid, non-grafted) | Each | 1.70 |
| Grape plants (*Vitis labruscana* , non-grafted) | Each | 1.65 |
| Grape plants (American Hybrids, non-grafted) | Each | 2.08 |
| Grape plants (*Vitis aestivalis* ) | Each | 2.25 |
| Grape plants (*Vitis rotundifolia* , non-grafted) | Each | 4.50 |
| Annual cover crop (rye grass seed) | Per lb | 0.45 |
| Perennial cover (k-31 fescue seed) | Per lb | 1.00 |

**Table A3. Prices for trellis and irrigation system installation**

| Input | Unit | Price |
|---|---|---|
| Wooden line posts 3" by 8' | Each | $ 5.35 |
| Metal line posts 8' | Each | 4.50 |
| End posts 6" x 8' | Each | 12.30 |
| Anchors | Each | 5.95 |
| Growth tubes | Each | 0.60 |
| # 9 wire Ht (1724 ft/cwt) | Lb | 0.73 |
| # 12.5 (4000 ft coil al. Clad) | Coil | 65.95 |
| # 13 wire Ht (4080 ft/cwt) | Lb | 0.73 |
| Wire clips | Each | 0.06 |
| Clips | Each | 0.03 |
| Tensiometer | Each | 66.25 |
| Tensiometer service kit | Each | 36.00 |
| Clips (irrigation hose) | Each | 0.04 |
| Pipes (main headers) | Foot | 0.46 |
| Pipes (in-line emmiters) | Foot | 0.25 |

**Table A.4. Fertilizer Costs per Application**

| | Approx Date | Units | Price ($/unit) | Amount applied ( yr 1) | Amount applied (yrs 2-30) |
|---|---|---|---|---|---|
| UAN (Nitrogen 32%)* | May 15 | Lb | 0.07 | 15.6 | 31 |
| UAN (Nitrogen 32%)* | Jun 15 | Lb | 0.07 | 15.6 | 31 |
| UAN (Nitrogen 32%)* | Jul 15 | Lb | 0.07 | 15.6 | 31 |
| 13-13-13 | Apr 15 | Lb | 0.1 | 200 | 400 |
| Dolomitic Lime | Mar 15 | Ton | 28.77 | 2 | 0 |

*Applied through fertigation

**Table A.5. Spray Prices and Costs**

| Product | Package size | Package unit | Package cost | Ammount applied | Unit applied | Cost per unit applied | Application cost | Spot Spray cost |
|---|---|---|---|---|---|---|---|---|
| ***Herbicides*** | | | | | | | | |
| Gramoxone Max (paraquat)* | 2.5 | gal | 102.50 | 2.5 | pt | 5.13 | 4.80 | 3.20 |
| Roundup | 1 | gal | 26.00 | 3 | qt | 6.50 | 19.50 | 4.88 |
| Surflan* | 1 | gal | 94.00 | 6 | pt | 11.75 | 26.44 | |
| Karmex (Diuron)* | 5 | lbs | 15.00 | 3 | lbs | 0.38 | 9.00 | |
| ***Insecticides and Fungicides*** | | | | | | | | |
| Captan 50W | 30 | lbs | 88.75 | 3 | lb | 2.96 | 8.88 | |
| Dithane DF (mancozeb) | 30 | lbs | 84.00 | 3 | lb | 2.80 | 8.40 | |
| Sevin 80S | 10 | lbs | 53.50 | 2.5 | lb | 5.35 | 13.38 | |
| Sevin XLR Plus | 2.5 | gal | 73.50 | 2 | qt | 7.35 | 14.70 | |
| Goal 2XL | 2.5 | gal | 245.00 | 5 | pt | 12.25 | 61.25 | |
| Ridomil gold | 1 | gal | 661.00 | 2.5 | lb | 165.25 | 413.13 | |
| Nova 40W | 20 | oz | 76.20 | 4 | oz | 3.81 | 15.24 | |
| Abound | 1 | gal | 245.00 | 11 | fl oz | 1.91 | 21.05 | |
| Poast | 2.5 | gal | 185.00 | 2 | pt | 9.25 | 18.50 | |
| Ferbam | | N/A | N/A | 3 | lb | 5.00 | 15.00 | |
| Lorsban 4E | 2.5 | gal | 115.00 | 4.5 | pt | 5.75 | 25.88 | |
| Lime Sulphur | 55 | gal | 290.50 | 10 | gal | 5.28 | 52.82 | |

*Applied to berm only (.375 acres of berm in 1 acre of vineyard)

# Appendix B:
# Sequences of Operations

**Table B1: Sequence of Operations for Hybrids, *V. labruscana*, and *V. aestivalis*.**

| Description | Appox. Date | Product | Total cost ($/ac) |
|---|---|---|---|
| ***Machinery Sequence (Year 0)*** | | | |
| Sub-soil (custom) | Sep | | 12.00 |
| ***Total Machinery (Year 0)*** | | | ***12.00*** |
| | | | |
| ***Spray Sequence*** | | | |
| Spray (custom) | Aug | Roundup | 24.50 |
| ***Total Spray and Fertilization (Year 0)*** | | | ***24.50*** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 0)** | | | **36.50** |
| | | | |
| ***Machinery Sequence (Year 1)*** | | | |
| Lime application (custom) | Mar | Lime | 61.54 |
| Plow (custom) | Mar | | 12.00 |
| Disk | Mar | | 11.03 |
| Spike harrow (custom) | Mar | | 6.00 |
| Transplanter (A) | Mar | Grape Plants | 1,616.58 |
| Trailer | Mar | | 14.02 |
| Disk | May | | 13.79 |
| Disk | Jun | | 13.79 |
| Disk | Jul | | 6.89 |
| Disk | Sep | | 6.89 |
| Drill permanent cover crop | Sep | Fescue | 14.75 |
| ***Total Machinery (Year 1)*** | | | ***1,777.28*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 1)*** | | | |
| *Fertilization* | | | |
| Fertilization 1 | May | UAN | 1.09 |
| Fertilization 2 | Jun | UAN | 1.09 |
| Fertilization 3 | Jul | UAN | 1.09 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.92 |
| Tractromount sprayer | Jun | Paraquat | 11.88 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Gun sprayer (B) | May | Captan | 14.39 |
| Gun sprayer (B) | Jun | Captan | 14.39 |
| Gun sprayer (B) | Jul | Captan + Nova | 29.63 |
| Gun sprayer (B) | Aug | Captan + Nova | 29.63 |
| ***Total Spray and Fertilization (Year 1)*** | | | ***173.83*** |
| | | | |
| ***Manual Labor Sequence (Year 1)*** | | | |
| Growth tube installation | Mar | | 93.95 |
| Train | May | | 91.19 |
| Train | Jun | | 45.60 |
| Train | Jul | | 45.60 |
| Growth tube removal | Sep | | 46.98 |
| ***Total Manual Labor*** | | | ***323.32*** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 1)** | | | **2,274.43** |

**Table B1: Sequence of Operations for Hybrids, *V. labruscana* , and *V. aestivalis* .**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Year 2)*** | | | |
| Trailer | Feb | | 14.02 |
| Bush hog | Apr | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jun | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| ***Total Machinery (Year 2)*** | | | ***42.22*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 2)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 (custom) | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.92 |
| Tractromount sprayer | Jun | Paraquat | 11.88 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Gun sprayer (B) | May | Captan | 14.39 |
| Gun sprayer (B) | Jun | Captan | 14.39 |
| Gun sprayer (B) | Jul | Captan + Nova | 29.63 |
| Gun sprayer (B) | Aug | Captan + Nova | 29.63 |
| ***Total Spray and Fertilization (Year 2)*** | | | ***221.05*** |
| | | | |
| ***Manual Labor Sequence (Year 2)*** | | | |
| Replant (5%) | Feb | Grape plants | 57.80 |
| Replant labor | Feb | | 28.19 |
| Growth tube instalation | Feb | | 23.49 |
| Train and sucker | Apr | | 49.74 |
| Train | May | | 49.74 |
| Train | Jun | | 49.74 |
| Train | Jul | | 24.87 |
| Growth tube removal | Aug | | 23.49 |
| ***Total Manual Labor (Year 2)*** | | | **307.06** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 2)** | | | **570.33** |

**Table B1: Sequence of Operations for Hybrids, *V. labruscana* , and *V. aestivalis* .**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Years 3-30)*** | | | |
| Trailer | Feb | | 7.01 |
| Bush hog | May | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jun | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Bush hog | Sep | | 5.64 |
| ***Total Machinery (Years 3-30)*** | | | ***46.49*** |
| | | | |
| ***Spray and Fertilization Sequence (Years 3-30)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 (custom) | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Karmex | 22.48 |
| Tractromount sprayer | Jun | Paraquat | 11.88 |
| Tractromount sprayer | Jul | Paraquat | 11.88 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| **Hybrids** | | | |
| Gun sprayer | Mar | Liq. Lime Sulfur | 58.33 |
| Vineyard sprayer | Mar | Sevin | 18.18 |
| Vineyard sprayer | Apr | Mancozeb | 13.20 |
| Vineyard sprayer | May | Mancozeb + Nova | 28.44 |
| Vineyard sprayer | May | Nova | 20.04 |
| Vineyard sprayer | May | Abound | 25.85 |
| Vineyard sprayer | May | Mancozeb + Nova + Sevin | 41.82 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jun | Abound + Captan + Sevin | 48.10 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Tractromount sprayer | Jul | Lorsban | 34.56 |
| Vineyard sprayer | Jul | Nova + Sevin | 33.42 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Vineyard sprayer | Aug | Captan + Sevin | 27.05 |
| ***Total Spray and Fertilization Hybrids (Years 3-30)*** | | | ***587.90*** |
| **Cynthiana** | | | |
| Vineyard sprayer | Apr | Mancozeb | 13.20 |
| Vineyard sprayer | May | Mancozeb | 13.20 |
| Vineyard sprayer | May | Mancozeb + Sevin | 28.44 |
| Vineyard sprayer | Jun | Captan + Sevin | 27.05 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| ***Total Spray and Fertilization Cynthiana (Years 3-30)*** | | | ***263.46*** |

**Table B1: Sequence of Operations for Hybrids, *V. labruscana*, and *V. aestivalis*.**

| | | | |
|---|---|---|---|
| ***V. labruscana*** | | | |
| Vineyard sprayer | Mar | Sevin | 18.18 |
| Vineyard sprayer | Apr | Mancozeb | 13.20 |
| Vineyard sprayer | May | Mancozeb + Nova | 28.44 |
| Vineyard sprayer | May | Nova | 20.04 |
| Vineyard sprayer | May | Abound | 25.85 |
| Vineyard sprayer | May | Mancozeb + Nova + Sevin | 41.82 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jun | Abound + Captan + Sevin | 48.10 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Tractromount sprayer | Jul | Lorsban | 34.56 |
| Vineyard sprayer | Jul | Nova + Sevin | 33.42 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| ***Total Spray and Fertilization V. labruscana (Years 3-30)*** | | | ***502.52*** |
| | | | |
| ***Manual Labor Sequence (Years 3-30)*** | | | |
| Prune, tie & brush removal | Feb | | 530.56 |
| Train & sucker | May | | 49.74 |
| Train | Jun | | 24.87 |
| Train | Jul | | 16.58 |
| ***Total Manual Labor (Years 3-30)*** | | | ***621.75*** |
| | | | |
| **Total Pre-harvest Variable Costs (Years 3-30) (A)** | | | **1,256.14** |

Notes:
(A) Table uses an average vine price for French-American Hybrids and will differ among varieties
(B) Application not used in sequence for *V. aestivalis*
(C) With exception of 13-13-13 Applications, fertilization is done through the irrigation system

**Table B.2: Sequence of Operations for *V. rotundifolia***

| **Operation** | **Appox. Date** | **Product** | **Total cost ($/ac)** |
|---|---|---|---|
| ***Machinery Sequence (Year 0)*** | | | |
| Sub-soil (custom) | Sep | | 12.00 |
| ***Total Machinery*** | | | ***12.00*** |
| ***Spray Sequence*** | | | |
| Spray (custom) | Aug | Roundup | 24.50 |
| ***Total Spray and Fertilization (Year 0)*** | | | ***24.50*** |
| | | | |
| **Total Pre-harvest Variable Cost (Year 0)** | | | **36.50** |
| | | | |
| ***Machinery Sequence (Year 1)*** | | | |
| Lime application (custom) | Feb | Lime | 4.00 |
| Plow (custom) | Feb | | 23.00 |
| Disk | Feb | | 11.03 |
| Spike harrow (custom) | Feb | | 6.00 |
| Transplanter | Feb | Grape Plants | 1,286.78 |
| Trailer | Feb | | 14.02 |
| Disk | Feb | | 11.03 |
| Drill permanent cover | Feb | Fescue | 25.75 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| ***Total Machinery (Year 1)*** | | | ***1,392.89*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 1)*** | | | |
| *Fertilization* | | | |
| Fertilization 1 | May | UAN | 1.09 |
| Fertilization 2 | Jun | UAN | 1.09 |
| Fertilization 3 | Jul | UAN | 1.09 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.93 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| ***Total Spray and Fertilization (Year 1)*** | | | ***85.80*** |
| | | | |
| ***Manual Labor Sequence (Year 1)*** | | | |
| Growth tube installation | Mar | | 33.16 |
| Train | May | | 33.16 |
| Train | Jun | | 16.58 |
| Train | Jul | | 16.58 |
| Growth tube removal | Sep | | 16.58 |
| ***Total Manual Labor (Year 1)*** | | | ***116.06*** |
| | | | |
| **Total Pre-harvest Variable Cost (Year 1)** | | | **1,594.75** |

**Table B.2: Sequence of Operations for *V. rotundifolia* (continued).**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Year 2)*** | | | |
| Bush hog | Feb | | 5.64 |
| Trailer | Mar | | 7.01 |
| Bush hog | May | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jun | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Bush hog | Sep | | 5.64 |
| ***Total Machinery (Year 2)*** | | | ***40.86*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 2)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 (custom) | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.93 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| ***Total Spray and Fertilization (Year 2)*** | | | ***133.03*** |
| | | | |
| ***Manual Labor Sequence (Year 2)*** | | | |
| Replant (5%) | Mar | Grape plants | 54.45 |
| Replant labor | Mar | | 10.03 |
| Growth tube installation | Mar | | 8.36 |
| Train & Sucker | May | | 24.87 |
| Train | Jun | | 24.87 |
| Train | Jul | | 24.87 |
| Train | Aug | | 12.44 |
| Growth tube removal | Sep | | 8.36 |
| ***Total Manual Labor (Year 2)*** | | | ***168.24*** |
| | | | |
| **Total Pre-harvest Variable Cost (Year 2)** | | | **342.13** |

**Table B.2: Sequence of Operations for *V. rotundifolia* (continued).**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Years 3-30)*** | | | |
| Bush hog | Feb | | 5.64 |
| Trailer | Feb | | 7.01 |
| Bush hog | May | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jun | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Bush hog | Sep | | 5.64 |
| ***Total Machinery (Years 3-30)*** | | | ***52.14*** |
| | | | |
| ***Spray and Fertilization Sequence (Years 3-30)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Karmex | 22.49 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Tractromount sprayer | Jul | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Orchard sprayer | Apr | Captan + Mancozeb | 22.08 |
| Orchard sprayer | Jun | Captan + Mancozeb | 22.08 |
| Orchard sprayer | Jun | Captan + Mancozeb | 22.08 |
| Orchard sprayer | Jul | Captan + Mancozeb | 22.08 |
| Tractromount sprayer | Jul | Lorsban | 34.56 |
| ***Total Spray and Fertilization (Years 3-30)*** | | | ***250.34*** |
| | | | |
| ***Manual Labor Sequence (Years 3-30)*** | | | |
| Prune, tie & brush removal | Feb | | 472.20 |
| Train and sucker | May | | 24.87 |
| Train | Jun | | 12.44 |
| Train | Jul | | 8.29 |
| ***Total Manual Labor (Years 3-30)*** | | | ***517.79*** |
| | | | |
| **Total Pre-harvest Variable Costs (Years 3-30)** | | | **820.27** |

Notes:
(C) With exception of 13-13-13 Applications, fertilization is done through the irrigation system

**Table B.3: Sequence of Operations for *V. vinifera***

| Operation | Appox. Date | Product | Total cost ($/ac) |
|---|---|---|---|
| ***Machinery Sequence (Year 0)*** | | | |
| Sub-soil (custom) | Sep | | **12.00** |
| ***Total Machinery (Year 0)*** | | | ***12.00*** |
| ***Spray Sequence (Year 0)*** | | | |
| Spray (custom) | Aug | Roundup | **24.50** |
| ***Total Spray and Fertilization (Year 0)*** | | | ***24.50*** |
| | | | |
| **Total Pre-harvest Variable Cost (Year 0)** | | | **36.50** |
| | | | |
| ***Machinery Sequence (Year 1)*** | | | |
| Lime application (custom) | Mar | Lime | 61.54 |
| Plow (custom) | Mar | | 12.00 |
| Disk | Mar | | 11.03 |
| Spike harrow (custom) | Mar | | 6.00 |
| Furrower (custom) | Mar | | 12.00 |
| Trailer | Mar | | 7.01 |
| Disk | May | | 13.79 |
| Disk | Jun | | 13.79 |
| Disk | Jul | | 6.89 |
| Disk (throw mound to protect graft) | Oct | | 46.00 |
| Drill annual cover crop | Oct | Rye grass | 14.75 |
| ***Total Machinery (Year 1)*** | | | ***204.79*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 1)*** | | | |
| *Fertilization* | | | |
| Fertilization 1 | May | UAN | 1.09 |
| Fertilization 2 | Jun | UAN | 1.09 |
| Fertilization 3 | Jul | UAN | 1.09 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.93 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Gun sprayer | May | Captan | 14.38 |
| Gun sprayer | Jun | Captan | 14.38 |
| Gun sprayer | Jul | Captan + Nova | 29.62 |
| Gun sprayer | Aug | Captan + Nova | 29.62 |
| ***Total Spray and Fertilization (Year 1)*** | | | ***173.80*** |
| | | | |
| ***Manual Labor Sequence (Year 1)*** | | | |
| Hand planting | Mar | Grape Plants | 2,788.00 |
| Hand Planting | Mar | hr/ac | 563.72 |
| Growth tube installation | Mar | hr/ac | 93.68 |
| Train | May | hr/ac | 91.19 |
| Train | Jun | hr/ac | 91.19 |
| Train | Jul | hr/ac | 45.60 |
| Growth tube removal | Sep | hr/ac | 45.60 |
| ***Total Manual Labor (Year 1)*** | | | ***3,718.98*** |
| | | | |
| **Total Pre-harvest Variable Cost (Year 1)** | | | **4,097.57** |

**Table B.3: Sequence of Operations for *V. vinifera* (continued).**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Year 2)*** | | | |
| Bush hog | Mar | | 5.64 |
| Trailer | Mar | | 7.01 |
| Grape hoe (pull down mound) | Mar | | 13.10 |
| Bush hog | Apr | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Disk | Oct | | 6.89 |
| Disk (throw mound to protect graft) | Oct | | 46.00 |
| Drill annual cover crop | Oct | Rye grass | 14.75 |
| ***Total Machinery (Year 2)*** | | | ***115.96*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 2)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 (custom) | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Surflan | 39.93 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Gun sprayer | May | Captan | 14.38 |
| Gun sprayer | Jun | Captan | 14.38 |
| Gun sprayer | Jul | Captan + Nova | 29.62 |
| Gun sprayer | Aug | Captan + Nova | 29.62 |
| ***Total Spray and Fertilization (Year 2)*** | | | ***221.03*** |
| | | | |
| ***Manual Labor Sequence (Year 2)*** | | | |
| Growth tube installation | Mar | | 23.49 |
| Replant (5%) | Mar | Grape plants | 119.00 |
| Replant labor | Mar | | 28.19 |
| Uncover graft & remove scion roots | Mar | | 49.74 |
| Train, sucker | Apr | | 116.06 |
| Train, shoot pos. | May | | 116.06 |
| Train, shoot pos. | Jun | | 116.06 |
| Train, shoot pos. | Jul | | 82.90 |
| Growth tube removal | Sep | | 23.49 |
| ***Total Manual Labor (Year 2)*** | | | ***674.98*** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 2)** | | | **1,011.97** |

**Table B.3: Sequence of Operations for *V. vinifera* (continued).**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Year 3)*** | | | |
| Bush hog | Feb | | 5.64 |
| Trailer | Feb | | 7.01 |
| Grape hoe (pull down mound) | Mar | | 13.10 |
| Bush hog | Apr | | 5.64 |
| Bush hog | May | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Disk | Oct | | 6.89 |
| Disk (throw mound to protect graft) | Oct | | 46.00 |
| Drill annual cover crop | Oct | Rye grass | 14.75 |
| ***Total Machinery (Year 3)*** | | | ***115.96*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 3)*** | | | |
| *Fertilization* (C) | | | |
| Fertilization 1 | May | UAN | 2.17 |
| Fertilization 2 (custom) | May | 13-13-13 | 44.00 |
| Fertilization 3 | Jun | UAN | 2.17 |
| Fertilization 4 | Jul | UAN | 2.17 |
| *Herbicides* | | | |
| Tractromount sprayer | Mar | Paraquat+Karmex | 22.49 |
| Tractromount sprayer | Jun | Paraquat | 11.89 |
| Tractromount sprayer | Jul | Paraquat | 11.89 |
| Gun sprayer (spot spray) | Aug | Roundup | 15.36 |
| Gun sprayer (spot spray) | Sep | Roundup | 15.36 |
| *Insecticides and Fungicides* | | | |
| Orchard sprayer | Mar | Sevin | 18.18 |
| Gun sprayer | Mar | Liq. Lime Sulfur | 58.32 |
| Vineyard sprayer | Apr | Mancozeb | 13.20 |
| Vineyard sprayer | May | Mancozeb + Nova | 28.44 |
| Vineyard sprayer | May | Ridomil Gold + Nova | 433.17 |
| Vineyard sprayer | May | Abound | 25.85 |
| Vineyard sprayer | May | Mancozeb + Nova + Sevin | 41.82 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jun | Abound + Captam + Sevin | 48.10 |
| Vineyard sprayer | Jun | Captan + Ferbam | 28.68 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Vineyard sprayer | Jul | Nova + Sevin | 33.42 |
| Vineyard sprayer | Jul | Captan + Sevin | 27.05 |
| Vineyard sprayer | Aug | Captan + Sevin | 27.05 |
| Tractromount sprayer | Jul | Lorsban | 34.56 |
| ***Total Spray and Fertilization (Year 3)*** | | | ***1,001.03*** |
| | | | |
| ***Manual Labor Sequence (Year 3)*** | | | |
| Prune, tie & brush removal | Feb | | 530.56 |
| Uncover graft & remove scion roots | Mar | | 49.74 |
| Train, sucker, shoot thin & pos. | May | | 223.83 |
| Train, wire lift, shoot pos., leaf removal | Jun | | 223.83 |
| Fruit thinning | Jun | | 124.35 |
| Train, wire lift, shoot pos. | Jul | | 124.35 |
| ***Total Manual Labor (Year 3)*** | | | ***1,276.66*** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 3)** | | | **2,393.65** |

**Table B.3: Sequence of Operations for *V. vinifera* (continued).**

| | | | |
|---|---|---|---|
| ***Machinery Sequence (Year 4)*** | | | |
| Bush hog | Feb | | 5.64 |
| Trailer | Feb | | 7.01 |
| Grape hoe (pull down mound) | Mar | | 13.10 |
| Bush hog | Apr | | 5.64 |
| Bush hog | May | | 5.64 |
| Summer Pruner | Jun | | 7.10 |
| Bush hog | Jul | | 5.64 |
| Summer Pruner | Jul | | 7.10 |
| Bush hog | Aug | | 5.64 |
| Disk | Oct | | 13.79 |
| Drill permanent cover crop | Oct | Fescue | 25.75 |
| ***Total Machinery (Year 4)*** | | | ***62.52*** |
| | | | |
| ***Spray and Fertilization Sequence (Year 4 is the same as Year 3)*** | | | |
| ***Total Spray and Fertilization*** | | | ***1,001.03*** |
| | | | |
| ***Manual Labor Sequence (Year 4 is the same as Year 3)*** | | | |
| ***Total Manual Labor*** | | | ***1,276.66*** |
| | | | |
| **Total Pre-harvest Variable Costs (Year 4)** | | | **2,340.21** |
| | | | |
| ***Machinery Sequence (Years 5-30)*** | | | |
| Bush hog | Feb | | 5.64 |
| Trailer | Feb | | 7.01 |
| Bush hog | May | | 5.64 |
| Bush hog | May | | 5.64 |
| Summer pruner | Jun | | 7.10 |
| Bush hog | Jun | | 5.64 |
| Summer pruner | Jul | | 7.10 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Jul | | 5.64 |
| Bush hog | Aug | | 5.64 |
| Bush hog | Sep | | 5.64 |
| ***Total Machinery*** | | | ***66.34*** |
| | | | |
| ***Spray and Fertilization Sequence (Years 5-30 are the same as Year 3)*** | | | |
| ***Total Spray and Fertilization (Years 5-30)*** | | | ***1,001.03*** |
| | | | |
| ***Manual Labor Sequence (Years 5-30)*** | | | |
| Prune, tie & brush removal | Feb | | 530.56 |
| Train, sucker, shoot thin & pos. | May | | 223.83 |
| Train, wire lift, shoot pos., leaf removal | Jun | | 223.83 |
| Fruit thinning | Jun | | 124.35 |
| Train, wire lift, shoot pos. | Jul | | 124.35 |
| ***Total Manual Labor (Years 5-30)*** | | | ***1,226.92*** |
| | | | |
| **Total Pre-harvest Variable Costs (Years 5-30)** | | | **2,294.30** |

Notes:
(C) With exception of 13-13-13 Applications, fertilization is done through the irrigation system

# Appendix C:
# Production Guide for Wine and Juice Grapes

**Table C1. Examples of key dates during the production season for several grape species at an Altus, AR location.**

| Species | *V. vinifera* | *V. aestivalis*<br>*V. labruscana*<br>French and American hybrids | *V. rotundifolia* |
|---|---|---|---|
| Trellis System | Vertical shoot position (VSP) | High wire, single curtain | High wire, single curtain |
| Example cultivar: | Chardonnay | Chambourcin (FAH) | Carlos |
| Bud burst | March 20<br>(mid-March) | March 27 | April 15 |
| Bloom | May 5 | May 10 | June 1 |
| Version | July 20 | July 25 | August 20 |
| Harvest | August 15-20 | August 25 | September 21 |

**Table C2. Calendar of operations for a producing Chardonnay vineyard on the vertical shoot positioned trellis system, Altus, AR.**

| | |
|---|---|
| January | • Order spray materials (for use in dormant season)<br>• Order vineyard supplies<br>• Check and repair equipment<br>• Attend grape educational meeting<br>• Begin pruning |
| February | • Complete pruning<br>• Shred prunings or remove from vineyard and burn<br>• Repair trellis systems<br>• Tighten wires<br>• Tie vines as needed<br>• If cultivar was infested with anthracnose last growing season, spray vines with lime sulfur or other recommended fungicide prior to bud burst<br>• Order spray materials (for use in growing season)<br>• Eliminate perennial or biennial weeds before bud burst with approved herbicide |
| March | • Inspect irrigation system and make needed repairs so system is ready to use<br>• Apply pre-emergent herbicides<br>• Scout for insects that damage buds (cutworms, flea beetles, etc.) and spray as needed<br>• Late March: Apply fungicide and insecticide according to Grape Pest Management Guide |
| April | • Mow or cultivate row middles<br>• Apply fungicides and pesticides according to Grape Pest Management Guide<br>• Order fertilizer (based on petiole analysis and cropping history)<br>• Begin monitoring soil moisture levels and irrigate as needed<br>• Late April: Shoot thin vines to remove non-count shoots unless needed for spur replacement<br>• Scout for insect and disease problems<br>• Place removable catch wires in initial location, position shoots up, and tuck shoots<br>• Remove suckers from the base of the vine |

**Table C2. Calendar of operations for a producing Chardonnay vineyard on the vertical shoot positioned trellis system, Altus, AR (Continued).**

| | |
|---|---|
| May | • Make second wire move, position shoot up, tuck shoots<br>• Basal leaf removal (north or east side only, depending on row orientation)<br>• Begin cluster thinning by mid-May<br>• Apply fertilizer (side dress or inject through drip system)<br>• Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Spot treat perennial weeds with post-emergence herbicides<br>• Scout for insect and/or disease problems<br>• Mow or cultivate row middles<br>• Monitor soil moisture levels and irrigate as needed |
| June | • Complete cluster thinning by mid-June<br>• Early June: Final wire move, position shoots up, tuck shoots<br>• Top shoots when they reach 18 – 24” above fixed wire at the top of posts<br>• Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Scout for insects and/or disease problems<br>• Spot treat perennial weeds with post-emergent herbicides<br>• Mow or cultivate row middles<br>• Monitor soil moisture levels and irrigate as needed<br>• Remove suckers from the base of the vine |
| July | • Collect leaf petioles for analysis of vine nutrient status in Mid-July<br>• Prepare the vineyard and equipment for harvest<br>• Continue pest control program; carefully monitor pre-harvest intervals for pesticides being used<br>• If bird netting will be used, apply at veraison (color change in fruit)<br>• Scout for insect and disease problems<br>• Mow or cultivate row middles<br>• Irrigate as needed<br>• Begin monitoring fruit maturation shortly after veraison |
| August | • Continue monitoring fruit maturation<br>• Continue pest control program; carefully monitor pre-harvest intervals for pesticides being used<br>• Scout for insect and/or disease problems<br>• Irrigate as needed<br>• Harvest when optimum maturity is reached |

**Table C2. Calendar of operations for a producing Chardonnay vineyard on the vertical shoot positioned trellis system, Altus, AR (Continued).**

| | |
|---|---|
| September | • Irrigate as needed<br>• Continue disease management efforts for powdery and/or downy mildew<br>• Mow or cultivate row middles<br>• Plan annual cover crop by late September if cultivated middle rows are used<br>• Broadcast fertilizer application for cover crop (if cultivated middle rows are used)<br>• Hill up soil to cover graft unions if vines are under five years old |
| October | • Collect soil samples for analysis<br>• Clean equipment<br>• Make equipment repairs |
| November and December | • Determine profitability of vineyard<br>• Review disease, insect and weed management strategies<br>• Review marketing strategies<br>• Develop goals and strategies for the coming season<br>• Inventory supplies and prepare lists of needed supplies for the coming season |

**Table C3. Calendar of operations for a producing Chambourcin vineyard on the single curtain trellis system, Altus, AR.**

| | |
|---|---|
| January | • Order spray materials (for use in dormant season)<br>• Order vineyard supplies<br>• Begin pruning<br>• Check and repair equipment<br>• Attend grape educational meeting |
| February | • Complete pruning<br>• Shred prunings or remove from vineyard and burn<br>• Repair trellis system<br>• Tighten wires<br>• Tie vines as needed<br>• If cultivar was infested with anthracnose last growing season, spray vines with lime sulfur or other recommended fungicide prior to bud burst<br>• Order spray materials (for use in growing season)<br>• Eliminate perennial or biennial weeds before bud burst with approved herbicide |
| March | • Inspect irrigation system and make needed repairs so system is ready to use<br>• Apply pre-emergent herbicides<br>• Scout for insects that damage buds (cutworms, flea beetles, etc.) and spray as needed |
| April | • Early April: Begin applying fungicide and insecticide according to Grape Pest Management Guide<br>• Order fertilizer (based on petiole analysis and cropping history)<br>• Begin monitoring soil moisture levels and irrigate as needed<br>• Mow row middles<br>• Mid April: Shoot thin vines to remove non-count shoots unless needed for cane position replacement<br>• Scout for insect and disease problems<br>• Late April: Position shoots down and separate, break tendrils (this practice devigorates shoots, reduces vine size, and can improve canopy microclimate; should only be done on blocks with large vine size and vigor)<br>• Remove suckers from the base of the vine |

**Table C3. Calendar of operations for a producing Chambourcin vineyard on the single curtain trellis system, Altus, AR (Continued).**

| | |
|---|---|
| May | • Second shoot positioning – position shoots down and separate, break tendrils( allows weight of fruit to force shoots down)<br>• Begin cluster thinning by mid-May<br>• Basal leaf removal should be done for clusters that are susceptible to bunch rot (done on north or east side of canopy only, depending on row orientation; a single layer of leaves should be retained above clusters to avoid direct exposure to sunlight and excessive berry temperatures)<br>• Apply fertilizer (side dress or inject through drip system)<br>• Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Spot treat perennial weeds with post-emergence herbicides<br>• Scout for insect and/or disease problems<br>• Spot treat perennial weeds with post-emergent herbicides<br>• Mow row middles<br>• Monitor soil moisture levels and irrigate as needed |
| June | • Early June: Third shoot positioning (position shoots down and separate, break tendrils)<br>• Complete cluster thinning by mid-June<br>• Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Scout for insects and/or disease problems<br>• Spot treat perennial weeds with post-emergent herbicides<br>• Mow row middles<br>• Monitor soil moisture levels and irrigate as needed<br>• Remove suckers from the base of the vine |
| July | • Collect leaf petioles for analysis of vine nutrient status in Mid-July<br>• Continue pest control program<br>• Scout for insect and disease problems<br>• Mow row middles<br>• Irrigate as needed<br>• Prepare the vineyard and equipment for harvest<br>• If bird netting will be used, apply at veraison (color change in fruit) |
| August | • Begin monitoring fruit maturation shortly after veraison<br>• Continue pest control program; carefully monitor pre-harvest intervals for pesticides being used<br>• Scout for insect and/or disease problems<br>• Irrigate as needed |

**Table C3. Calendar of operations for a producing Chambourcin vineyard on the single curtain trellis system, Altus, AR (Continued).**

| | |
|---|---|
| September | • Continue monitoring fruit maturation<br>• Harvest when optimum maturity is reached<br>• Continue disease management efforts for powdery and/or downy mildew<br>• Mow row middles |
| October | • Collect soil samples for analysis<br>• Clean equipment<br>• Make equipment repairs |
| November and December | • Determine profitability of vineyard<br>• Review disease, insect and weed management strategies<br>• Review other production strategies<br>• Review marketing strategies<br>• Develop goals and strategies for the coming season<br>• Inventory supplies and prepare lists of needed supplies for the coming season |

**Table C4. Calendar of operations for a producing Carlos vineyard on the Single Curtain trellis system, Altus, AR.**

| | |
|---|---|
| January | • Order vineyard supplies<br>• Begin pruning<br>• Check and repair equipment<br>• Attend grape educational meeting |
| February | • Complete pruning<br>• Shred prunings or remove from vineyard and burn<br>• Repair trellis system<br>• Tighten wires<br>• Tie vines as needed<br>• Order spray materials (for use in growing season)<br>• Eliminate perennial or biennial weeds before bud burst with approved herbicide |
| March | • Inspect irrigation system and make needed repairs so system is ready to use<br>• Apply pre-emergent herbicides |
| April | • Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Order fertilizer (based on tissue analysis and cropping history)<br>• Scout for insect and disease problems<br>• Begin monitoring soil moisture levels and irrigate as needed |
| May | • Mow row middles<br>• Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Scout for insect and/or disease problems<br>• Apply fertilizer (side dress or inject through drip system)<br>• Monitor soil moisture levels and irrigate as needed |
| June | • Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Scout for insects and/or disease problems<br>• Mow row middles<br>• Apply fertilizer (inject through drip system)<br>• Apply post-emergence herbicide<br>• Monitor soil moisture levels and irrigate as needed |

**Table C4. Calendar of operations for a producing Carlos vineyard on the Single Curtain trellis system, Altus, AR (Continued).**

| | |
|---|---|
| July | • Apply fungicide and insecticide according to Grape Pest Management Guide<br>• Scout for insect and disease problems<br>• Mow row middles<br>• Apply fertilizer (inject through drip system)<br>• Apply post-emergence herbicide<br>• Irrigate as needed |
| August | • Mow row middles<br>• Irrigate as needed<br>• Spot treat perennial weeds with post-emergence herbicides<br>• Collect leaf blades for analysis of vine nutrient status in mid-August<br>• Prepare the vineyard and equipment for harvest<br>• Begin monitoring fruit maturation shortly after veraison |
| September | • Mow row middles<br>• Irrigate as needed<br>• Spot treat perennial weeds with post-emergence herbicides<br>• Continue monitoring fruit maturation<br>• Harvest when optimum maturity is reached |
| October | • Irrigate as needed<br>• Collect soil samples for analysis<br>• Clean equipment<br>• Make equipment repairs |
| November and December | • Determine profitability of vineyard<br>• Review disease, insect and weed management strategies<br>• Review other production strategies<br>• Review marketing strategies<br>• Develop goals and strategies for the coming season<br>• Inventory supplies and prepare lists of needed supplies for the coming season |

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