

# **The Technological and Economic Framework of Wine and Juice Production in Arkansas** AAESBul941 1994

Carl R Dillon, Assistant Professor, Dept. of Agricultural Economics and Rural Sociology, University of Arkansas

Carter Price, Professor, Dept. of Agricultural Economics and Rural Sociology, University of Arkansas

Justin Morris, University Professor, Department of Food Science, University of Arkansas

David Metz, Marketing Director, Prospero Equipment Corporation, Pleasantville, New York

Arkansas Agricultural Experiment Station, Fayetteville, Arkansas 72701

## **PREFACE**

Planning for a successful winery and juice plant requires a thorough comprehension of the technological and economic environment under which the manager of such a business has to operate. Some basic cost data, technological data and other economic data were assimilated to provide benchmarks for evaluation of the operations of a firm in this industry. Coupled with a review of selected literature, a discussion of winemaking, a presentation of grape juice production and economic interpretation, the underlying framework for the small- to medium-sized winery/juice plant is examined.

## **ACKNOWLEDGMENTS**

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## **INTRODUCTION**

The economic and technological framework of the production processes defines the conditions under which the winery manager has to operate. Understanding that underlying framework sets the stage for developing a successful plan to operate an economically profitable winery. Increasing profits through proper production, marketing and financial management requires knowledge of the business. The objective of this study was to summarize the technological and economic data to provide guidelines that will assist producers of wine and juice in small- to medium-sized firms.

To achieve the objective, the following steps were undertaken:

- A. Interviews with experts within the industry and informal surveys of winery managers and operators were conducted to supplement the collection of data from previously published sources.
- B. Guidelines for output prices, input prices, technological requirements and marketing limitations were established with subsequent evaluation of the reliability of the collected information.

The remainder of this report is organized as follows. First, background information is provided. The technological framework addressing aspects of the art of winemaking and grape juice production techniques is presented next. Following this, the economic framework is investigated with concluding comments ending this report.

## **BACKGROUND INFORMATION**

The background information includes the focus of the study and a review of literature; the latter can expand the reader's information base upon which to make good managerial decisions.

### **Focus of Study**

This study focuses on several major components. The varietal grapes, geographical location and winemaking capacity must be defined. The major varietal wines produced in Arkansas are included. For red wines this includes Cabernet Sauvignon, Chambourcin, Chancellor and Cynthiana with Concord included primarily as a juice grape. The white wines investigated are Chardonnay, Riesling, Niagara, Vignoles, Vidal and Seyval. Vidal and Seyval will be discussed together as no differences in terms of the technological (e.g., yield) or economic (e.g., price) framework were found. Table 1 lists the expected harvest dates for two important production regions in Arkansas, the Altus and Fayetteville areas. While the study concentrates on data specific to the Arkansas region, this does not preclude results of the study being relevant to similar economic and technological circumstances elsewhere. Nonetheless, care should be taken in making inferences regarding other areas. Six different sizes of small to medium wineries, as measured in annual winemaking (fermenting) capacity in gallons, are included in the study. These wineries are 100,000, 80,000, 40,000, 20,000, 10,000 and 5,000 gallons. These capacity categories reflect the limitations on winemaking imposed by each plant's refrigeration and related annual fermentation capacity. Juice production, which is not limited by fermentation capacity, was also included. The rationale for the addition of juice making will be discussed in the section entitled "Grape Juice Production".

**Table 1. Harvest dates for Fayetteville and Altus, Arkansas, by cultivar.**

Cultivar	Harvest Date (Fayetteville)	Cultivar	Harvest Date (Altus)
<b>White</b>		<b>White</b>	
Chardonnay	8-16	Chardonnay	8-07
Riesling	8-20	Riesling	8-14
Niagara	8-19	Niagara	8-10
Vignoles	8-20	Vignoles	8-14
Vidal	8-28	Vidal	8-11
Seyval	8-09	Seyval	8-02
<b>Red</b>		<b>Red</b>	
Cabernet Sauvignon	9-06	Cabernet Sauvignon	8-27
Chambourcin	8-28	Chambourcin	8-21
Chancellor	8-14	Chancellor	8-06
Cynthiana	9-06	Cynthiana	8-30
Concord	8-26	Concord	N/A

Source: 10-year means for two locations in Arkansas: 1) University of Arkansas Research Vineyards and 2) commercial vineyards in the Altus region.

### Review of Literature

The published literature in the U.S. dealing with wine and juice production emphasizes the processes involved and the technological aspects rather than economic considerations. Grape production budgets dominate the economics literature related to the wine industry (e.g., Kirchner et al., 1988; Kirpes and Folwell, 1984; Johnson, 1977; Vaden, 1987). Of the economic analyses not oriented to strictly vineyard management aspects, the emphasis is on investment analysis and operating costs (e.g., Folwell and Castaldi, 1987, 1988; Moulton, 1981; Vreeland et al., 1982), consumption and demand (e.g., Tsolakis, 1983; Tsolakis et al., 1983; Blaylock and Blisard, 1993; Johnson et al., 1992; Selvanathan, 1991; Tegene, 1990; Shapouri et al., 1981) and market structure (e.g., Folwell, 1974; Morse, 1990). However, little attention has been focused upon combining the decision-making processes involved in both production and marketing strategies, especially for small- to intermediate-sized wineries. The few studies that have been published emphasize the need for further economic research to address the business and technological challenges of these sizes of wineries. Nonetheless, recent economic studies concentrating on the Arkansas wine industry have focused on profitability through sound production management and marketing strategies (Dillon et al., 1992b, 1993a), adding a juice line to a winery (Dillon et al., 1992a, 1993b) and capital investment in the winery/juice plant (Price et al., 1993). Readers interested in a detailed economic analysis should see Dillon et al., 1994. For a comparison of Eastern U.S. wineries to West Coast wineries, see Dillon et al., 1993c.

Other studies have revealed that attention to management and business decision making is imperative to the successful operation of a winery business (Dillon et al., 1992b; Cooke et al., 1975; Zoecklein, 1990; Keehn, 1981; Wolf, 1981). The development of an effective business plan includes attention to production management decision making, strategic marketing and appropriate financing. The marketing strategy for wineries incorporates product quality, product demand, advertising and product appearance and display (Clancy, 1981). Wineries that wish to remain economically successful need to adequately address consumer demands (Cooke et al., 1975; Peterson, 1975; Wolf, 1981; Clancy, 1981). The economic business plan must incorporate both the production and marketing strategies (Keehn, 1981; Zoecklein, 1990; Cooke et al., 1975; Dillon et al., 1992a and 1992b).

Much of the economic literature dealing with wineries has dealt with the reporting of cost of production (e.g., Folwell and Castaldi, 1988; Zoecklein, 1990; Moulton, 1981). The cost of grapes was generally accepted as being the single most expensive input, although the cost of labor was a substantial portion of expenditures. Zoecklein (1990) shows the cost of grapes representing 39% of total production costs with labor representing about 11%. Of the 14 responses reported in a survey conducted by Moulton (1981), the average reported total cost per gallon of wine ranged from \$5.46 to \$15.48/gallon produced. While representing a wide range that may not be totally applicable to Arkansas and surrounding states, this information does provide some insight useful for approximate comparisons. Moulton also demonstrated that, in addition to production labor, sales and administrative labor accounted for 8% of production cost. The average total cost of wine per gallon from the Moulton survey was \$10.36.

Capital requirements for equipment have also been discussed in the literature (Folwell and Castaldi, 1988; Zoecklein, 1990; Robbins, 1981; Moorhead, 1978; Vreeland et al., 1982). These studies demonstrate the capital-intensive nature of winemaking. The total investment cost for equipment reported in Folwell and Castaldi (1988) was \$1,168,575 in 1988 dollars for a 100,000-gallon winery. The two primary difficulties cited in starting a new winery were market entry and the amount of capital required for the establishment of a successful winery. See also Vreeland et al. (1982) for a discussion of winery equipment investment.

Much of the business-oriented wine literature has stressed the crucial nature of winery location. Economic literature that discusses the managerial aspects of planning and designing wineries has provided evidence of the vital importance of winery location (Zoecklein, 1990; Peterson, 1975; Cooper, 1981). The selected location must be in an area suitable to the production of high-quality wine grapes in order to maintain the quality necessary in successful wine marketing. Close proximity to adequate transportation facilities and systems is also required for timely delivery of product, receipt of supplies and the encouragement of customer traffic in the tasting/sales room. Potential for tourist interest or repeat customers is often essential for a successful small winery operation. The location can also affect the mix of wine types sold. Some high-traffic locations bring in different categories of retail customers. Also, some locations may find a greater number of wine drinkers desiring fruity, sweeter wines of high quality rather than drier wines. If these wines are less expensive to produce, their increased sales will boost overall profits of the winery (Dillon et al., 1992b).

Experience has demonstrated that the location or site plan should successfully incorporate all facilities of the complex into not only a productive physical layout but also one that is pleasant and attractive to customers. Consideration of customer access includes safe interaction of visitor facilities to processing areas and attractive placement of roads and entrances for the variety of winery traffic. The site plan should consider the image chosen for the winery with particular importance placed on the impact the main entrance is expected to make. It is no simple thing to plan a design that successfully incorporates the winery's image with the ideal processing facilities, interaction of visitors and allowances for future expansion. Many of the newer wineries are designing a floor plan that allows for self-guided tours. Although this saves money on tour guides, self-guided tours must be planned and managed very carefully to prevent accidents. Visitors' facilities can be expanded to include wine tasting areas, restaurants, exhibition rooms or museums, formal or informal exterior areas and any other creative facility that the winery owner believes will be of interest to visitors and will result in repeat business.

The winery owner must consider all aspects of the winery's relationship with the intended site and surrounding community. This will include acreage, winemaking capacity, image and lifestyles of the community. However, of paramount importance is the community's social attitude toward the acceptance of wine. Cities and counties have varying legal stances on alcoholic beverages. Dry counties may allow wineries and wine production but not sale of the product on site. This is obviously a serious complication that must not be overlooked.

## **HISTORY**

**Wine** Grapes were first grown commercially in Arkansas at Altus (Franklin County) in the foothills of the Ozark Mountains by a colony of German-Swiss who settled that region in the 1870s. These early viticulturists soon recognized the potential of the region for grape production.

The Boston Mountains to the north provided a barrier to the winter cold, and the elevation of the small, flat top mountains provided the necessary protection from spring frost. These German-Swiss immigrants had found both the soil and the climate suited to grape production.

Early winemakers found a ready market for their product among the immigrant railroad workers and coal miners who were accustomed to enjoying wine with their meals. Some of the early winemakers in the area were Wiederkehr, Post and Sax. Several wineries still operate in the Altus area and are run by the fourth- and fifth-generation descendants of these original wine families.

During the Prohibition era, many of the wine grape vines were grafted over to table grape cultivars. Private grape breeders such as Joseph Bachman developed the 'Sunrise', 'Stark's Star' and 'Banner' cultivars. Herman Wiederkehr discovered a bud mutation of 'Campbell's Early' during this period and sold the propagation rights to Stark Brothers Nurseries. This became Stark's patent No. 1.

With the repeal of Prohibition, the wineries in the Altus area expanded significantly. Most of the plantings now are devoted to the best of the French-American hybrids and the hardy *Vitis vinifera*. Al Wiederkehr of Wiederkehr Wine Cellar is given credit for pioneering the first commercial *vinifera* plantings in Arkansas.

Another early grape production center was established in northwestern Arkansas (Washington County) by Italian immigrants. In 1895, 100 Italian families landed in New Orleans and came first to Sunnyside, Arkansas, in the southeastern corner of the state, to settle on a large plantation owned by Austin Corbin. In 1896, more families arrived in New York and then joined the colony. Three years after their arrival, a double tragedy struck. Their benefactor, Corbin, died, and a malaria epidemic spread throughout the new colony. Over 100 people died in one year. These Italians from the mountainous climate of the Alps and Apennines could not acclimate to the conditions of southeastern Arkansas swamps.

Father Bandini, a Catholic priest in New York, heard of the tragedy of the Italian immigrants and came to their rescue. He gathered the 20 remaining families and brought them to northwestern Arkansas where he purchased 700 acres of land and founded Tontitown. These Italians soon found that the 'Concord' juice grape as well as hardy wine grapes thrived in this area and produced excellent-quality fruit.

Early wineries were established in the Tontitown area, but none of these are operating today. However, wine grapes are still produced in the northwestern Arkansas area and shipped to wineries in the Altus area (Morris, 1976).

**Grape Juice** Grape juice was first made in the United States by Dr. Thomas B. Welch, a dentist, with the help of his wife and their 17-year-old son, Charles. The Welch family used 'Concord' grapes that were growing in their home vineyard in Vineland, New Jersey. The juice was first used in 1869 for the sacrament on the Communion table of the Methodist Church in Vineland, New Jersey. Orders for the juice, mainly for Communion, increased until most of the Welch family's time was devoted to preparing grape juice. Charles Welch took over the grape juice business in 1872, and in 1896 he moved his new business to Watkins Glen, New York. In 1897 he built a plant in Westfield, New York, and processed 272 metric tons (300 U.S. short tons) of grapes. By 1902 this plant was processing 2723 metric tons (3000 U.S. short tons). These developments made commercial grape juice processing an original United States development (Chazanof, 1977).

The processing of grape juice in Arkansas started in 1922 when Welch Foods built a plant in Springdale. In the late 1980s and early 1990s, local wineries developed considerable interest in processing and marketing grape juice.

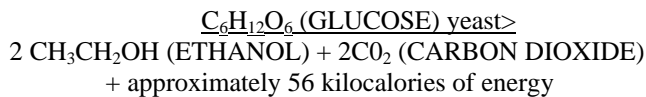
### **THE TECHNOLOGICAL FRAMEWORK**

Ultimately, sound economic decision making in any business is driven by the underlying technological framework. Knowledge of the art of winemaking and, if it is engaged in, the production of grape juice, defines the production technology used in economic decision making for the greatest profitability.

Winemaking is a complicated process that involves both science and art and requires a series of stages or steps. While there is no single distinct and all-inclusive pattern for winemaking, the steps that are assumed within this study for both white and red wine production are presented in Fig. 1. A discussion of the steps involved in winemaking follows.

#### **Introduction to Winemaking**

Winemaking involves the process of fermentation, (i.e. converting sugars of grapes into alcohol and carbon dioxide). The following is a simple equation for the anaerobic reaction:



The making, aging and marketing of a high-quality wine can be an expensive and complicated process. The first requirement for producing a high-quality wine is a suitable grape cultivar. Red wines are made from red grapes, and white grapes ordinarily are used for white wines. Sometimes white and blush wines are made by cold pressing red grapes instead of fermenting the juice with the skins. The chosen cultivar must be produced on a site with suitable soil and under profit maximizing cultural practices and good plant leaf canopy management techniques to allow for production of high-quality fruit. A productive canopy-management program involves allowing for the proper exposure of the leaves and clusters to sunlight in order to produce high quality grapes.

The character and quality of a wine is determined by 1) the chemical composition of the grapes, which depends to a large extent on site, season, grape cultural conditions, canopy-management and fruit maturity; 2) the fermentation style and methods; and 3) the changes that occur naturally, or are made to occur, during the post-fermentation and aging period (Amerine et al., 1982).

Once grapes have been harvested at a point of high fruit quality, it is critical that they be handled in a manner that will prevent deterioration of quality. Juice from damaged grapes is subject to enzymatic oxidation and spoilage that will deteriorate wine color and produce off flavors. The higher the fruit temperatures, the faster these undesirable reactions occur (Morris et al., 1979). When machine harvesting is used, the vineyards need to be close to the winery. If the grapes are to be transported long distances, they need to be chilled before transportation. In some cases, for short hauls of 4 to 6 hours, mechanical harvesting at night, while the grapes are cool, is adequate to slow this deterioration. Sulfur dioxide may be added during the mechanical harvesting operation to slow enzymatic oxidation and suppress unwanted yeast and bacteria growth (Morns, 1983). Certain white wine styles preclude the use of machine harvesting and sulfur dioxide due to the resulting problem of extended skin contact time. Facilities at the winery for rapid destemming, crushing and pressing are equally as important as preharvest and harvest practices.

#### **Destemming/Crushing**

This operation consists of removing the grapes from their stems and crushing the grapes. The objective of crushing is to open up every grape so the juice can be easily drained with a minimum of damage to the grape skin. This is especially important for most white wines. The chemical composition of the juice can be changed during crushing as the result of the maceration of the skin tissue (Ough, 1991). This maceration stimulates enzyme activity and may cause undesirable reactions. Also, if the outer shells of the seeds are broken during crushing, high levels of phenolic materials from the seeds will impart a bitter taste to the wine.

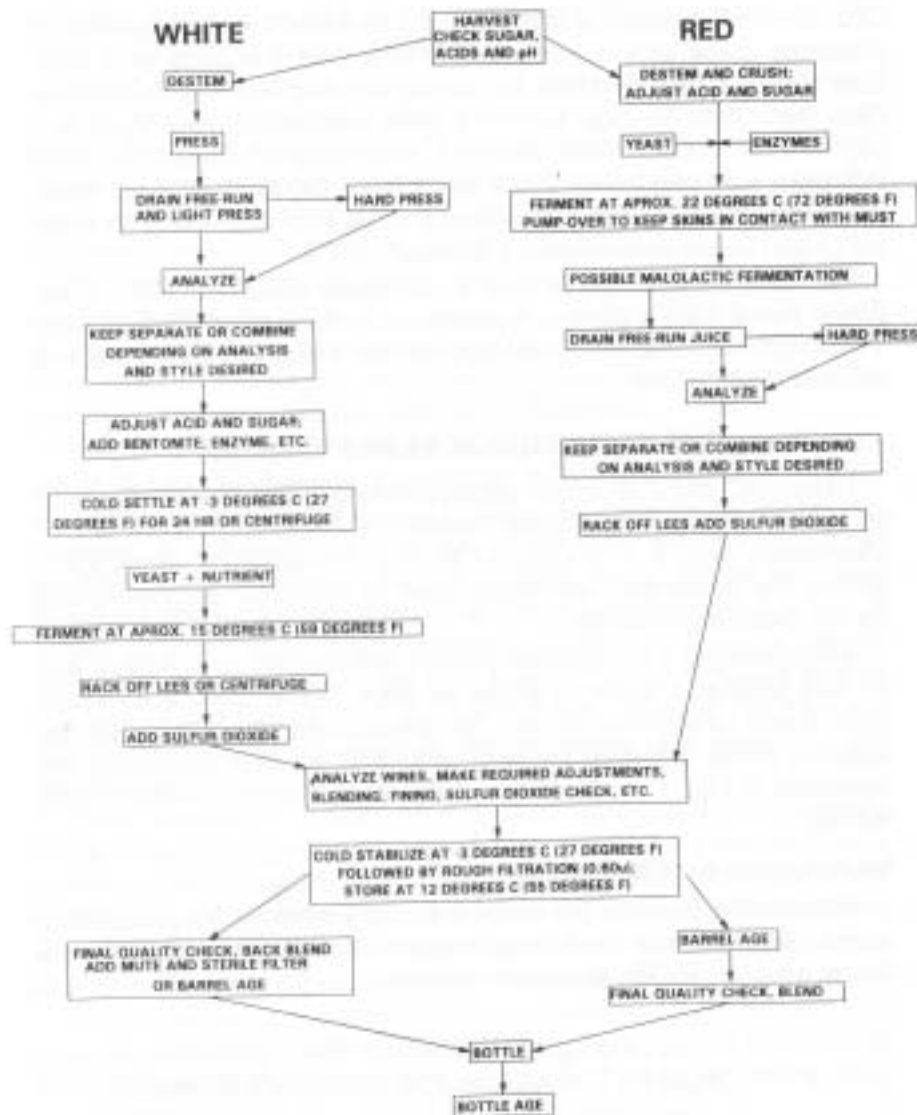


Fig. 1. The basic steps in producing and aging of white and red wine.

Equipment exists that will destem only, destem and crush or crush first and then destem. The traditional method of mechanical destemming consists of having the crusher rollers located ahead of the destemmer. However, there are advantages to destemming prior to crushing. This method prevents crushing of the stems and subsequent release of phenolic compounds into the must. For some higher-quality wines, it is best not to crush the grapes but to transfer the destemmed grapes directly into the press. For example, in the production of champagne cuvee, the grapes are usually pressed on the cluster and the destemming and crushing operations are completely bypassed. The crushing rollers should be designed and spaced to allow for the crushing operation without chopping or flattening the skins, cracking the seeds or breaking an excessive amount of stem tissue, because these processes add undesirable flavors and colors to the end product.

### Fermentation Tanks

Fermentation containers are made of various materials: oak or redwood, concrete, polyethylene, glass-lined steel and stainless steel. These fermenters have also been made in many different shapes and forms. However, most modern wineries have installed stainless steel tanks that are jacketed (for glycol or ammonia circulation as a temperature controller). Many of these temperature controlled, stainless steel tanks are equipped for automatic pumping over the cap for red wine production and designed so that the tank bottom is sloped with openings allowing for easy pomace removal.

### Pressing

Presses, like fermentation tanks, also come in many sizes and shapes. Many large wineries in the past have installed presses that work on the principle of an endless spiral screw that continuously presses the pomace against a

counter-weighted movable stop that allows for a buildup of a thick plug. These presses have been extremely successful in grape juice processing operations. As a general rule the highest quality wine is obtained from the free-run juice must that has been recombined with the first press juice. The hard press juice is high in phenolic compounds as well as other compounds that can have a significant effect on pH, bitterness and astringency. The winemaker blends the various press fractions depending on the wine style desired.

In this study, as in most modern medium-sized and large wineries, the press consists of a horizontal, pneumatic batch press that operates by inflating an internal bag made of thick rubber (bladder press) with compressed air. The bag crushes the must against an outer perforated, cylindrical stainless steel cage that acts as a sieve. In some presses, the juice or wine is collected through internal draining pipes. The breaking up of the press cake for harder and more complete pressing is accomplished by releasing the pressure on the bladder, breaking up the pomace when the horizontal cage is rotated. However, very small wineries cannot afford these expensive bladder presses.

An alternative and economical press for small wineries (5,000 to 10,000 gal) would be the vertical Idopress (water-operated bladder press). This press is built like the traditional vertical basket press but has an internal rubber bladder that is inflated to produce the pressing action. The water pressure from a garden hose is adequate to inflate the bladder and press the fruit evenly against the basket. Many small wineries will use two of these units. One unit will be pressing while the other is being emptied and refilled with grapes (Metz, 1992).

The quality of the pressed wine or juice and the final method or wine style selected are determined by analyses of the various press fractions. It should be mentioned that the best wineries are designed to transform the grapes into must or juice in a minimum amount of time to prevent oxidation.

### **Settling and/or Centrifuging**

For white wine production, the settling of the insoluble solids can be accomplished either by cold temperature and gravity or by centrifugation. Membrane-type presses will reduce the amount of settleable solids compared to other type presses. Some wineries use cold temperature settling of juice of white wine cultivars prior to fermentation and only use the centrifuge after fermentation. The centrifuge could also be used on red wines after fermentation. Removing the insoluble solids allows for the production of fruitier white wines and eliminates many off-flavors.

### **Filtering**

Proper filtration results in the removal of insoluble solids. Also, filtration is used to remove all microorganisms, assuring a microbiologically stable bottled product. During filtration the wine should come into contact only with surfaces made of stainless steel, since stainless steel is inert and can be easily steam cleaned. Stainless steel is expensive enough that some vintners in small wineries choose to use plastic.

Some 5,000-gallon wineries may start out with simple cartridge filters. Even though the housings are inexpensive, the high cost of the cartridges may make it more practical to use a plate and frame filter. Another method of filtering wines is to use a Diatomaceous Earth (DE) filter. A skilled operator of a DE filter can rough-filter a wine or can use the filter to accomplish a nearly complete filtration. However, these units require more expertise than do pad or cartridge filtration. Also, DE disposal is becoming a problem in some states because it is not allowed in landfills.

A lees filter, which is used to clean up the lees and tank bottoms, is usually a good investment. It increases wine yields and pays for itself quickly. Also, in small wineries, a lees filter can replace, to some extent, the need for cold settling or centrifuging juice by removing the insoluble solids (Metz, 1992).

### **Barrel Aging**

Various species of white oak are used to make wine barrels. French oak barrels are made primarily from Limousin or Nevers oaks. These oaks tend to impart a "vanilla" character to the wine and are preferred by some premium winemakers. American white oak barrels are about one-half as expensive as French oak barrels and, when used properly, are as acceptable as (or sometimes preferred to) French Oak barrels for some wines and styles.

During the barrel aging process, wines undergo a series of subtle yet fundamental changes in color and develop bouquet as the grape aroma of the young wine gradually dissipates (see glossary, page 31). During this aging process, the wine also clarifies and becomes stable. The wood of the barrel imparts tannins and flavors that add to the complexity of taste and bouquet of mature wines. The length of time required for aging depends on the wine, the wine style desired and the species of oak from which the barrel was made, as well as many other factors. Each winemaker has his own procedure or style for barrel aging.

### **Bottle Washing and Sparging**

Bottling is the logical end process for wines. Bottling is an important operation, and many enological problems can be prevented by proper bottling. It is important to keep out oxygen and microorganisms, especially any contamination from the bottling apparatus itself.

Most wineries rinse and clean new bottles. In recent years many new bottles have arrived at the winery containing mold, dust and other particles. Most bottle washers rinse with an SO<sub>2</sub> (sulphur dioxide) solution. A few wineries still use a jet of compressed air to remove dust. This method is not considered very effective and can be used only when glass bottle plants are nearby or there is a quick turnover in glass inventory or when glass bottles are stored under clean, low-humidity conditions.

## **Filling and Corking**

Filling must be accomplished with minimum exposure of the wine to air. A small 5,000- to 10,000-gallon winery may be able to justify only a six-spout gravity filler and a hand operated "floor corker." A GAI® model 2006 stainless steel unit has the capacity of 700 bottles per hour. For a 20,000- to 40,000-gallon operation, an eight-spout automatic filler-corker monoblock with a nine-spout bottle rinser station and inert gas sparger is recommended. The GAI® model 1503 unit has the production capacity of 1,500 bottles per hour. For an 80,000- to 100,000-gallon winery, the GAI® model 2503 twelve-spout filler, corker monoblock with a bottle rinser station and an inert gas sparger is recommended. This unit has the capacity of 2,500 bottles per hour (Metz, 1992). Descriptions of these and numerous other modern bottling and corking machines are available from their respective manufacturers.

In the future, methods will need to be developed to better manage cork quality. This problem of cork quality has become increasingly important. With greater loss of finished product due to "corked" wines (2,4,6-trichloroanisole). Some wineries consistently report losses of as much as 10% in their finished product.

## **Capsuler**

A capsule improves the appearance of the wine bottle and maintains the image of quality. Until 1990 the lead or tin/lead capsule was the choice of most premium wineries. However, the lead capsule recently fell from favor and was eliminated because of the possibility of traces of lead from the foil coming into contact with the wine when decanting. Wineries are looking at other options, such as tin/aluminum, heavy duty plastic and plastic heat-shrink capsules.

Most small wineries (5,000 to 10,000 gallon) apply these capsules by hand using a single motorized, bench-mounted, hand-fed spinner. The plastic heat-shrink capsules continue to improve in both appearance and application efficiency. They can be applied by hand and then conveyed through a small heat-shrink tunnel. Some plastic shrinks look cheap, and only the highest-quality plastic shrinks that are printed with a logo will convey the professional image desired in packaging of a quality wine (Metz, 1992).

Capsules can be applied automatically. An automatic capsule distributor should be installed when labor for hand application becomes too expensive. This usually occurs in the 20,000-gallon and larger wineries. Automatic distribution machines can hold up to 1,500 capsules in stacks in a magazine. As each bottle passes underneath, a photo electric cell detects the bottle, checks for a cork and then drops a capsule over the neck. Speeds of 1,000 to 6,000 bottles per hour are possible (Metz, 1992).

## **Labeling**

In an effort to save on capital investment, most small wineries label by hand. Hand labeling can cost from \$0.50 to \$1.00 per case, including labor. Hand labeling is usually separate from the bottling operation. Small wineries (5,000 to 10,000 gallon) can use either total hand labeling or a choice of semi-automatic labeling machines. One type has an automatic label feed from a tray and has the capacity of up to 700 bottles per hour. Another semi-automatic labeling machine for pressure-sensitive labels has a similar capacity. After a winery reaches the 20,000-gallon capacity, labeling automation becomes more prevalent. Many options are available. An automatic, in-line, pressure-sensitive labeling machine with an automatic capsule distributor and foil spinner or a heat-shrink oven is one choice. A linear labeling machine for full-width, wet-glue wrap-around labels or a rotary labeling machine with full-width glue application for a front, back and shoulder label are other options. These machines have the capacity of labeling from 2,000 to 3,000 bottles per hour (Metz, 1992).

## **Handling Machines**

When the speed of a small bottling line reaches about 50 bottles per minute, an accumulator table should be provided in advance of the labeler to insure an uninterrupted flow of bottles. The end of the line should have an unscrambling table.

## **Pumps**

Cellar pumps consist of four basic types: 1) centrifugal; 2) positive displacement; 3) flexible impeller; and 4) piston. Centrifugal pumps are excellent for moving large quantities of liquid quickly. The only real disadvantage to centrifugal pumps is that they require a large number of diverse hose and fitting sizes and the low head pressures that are achieved by the small size pumps.

Positive displacement pumps come in various configurations. The most common type uses two rotating lobes in a figure-eight-shaped chamber. Positive displacement pumps are volumetric with each rotation delivering the same volume of wine, regardless of pressure. These pumps are perfect for driving plate and frame filters, supplying bottling lines or any other application requiring accurate flow control and/or high pressure.

Piston pumps are still used by many wineries, but they are not recommended for a filter because of their pulsating action. For most situations a rotating-lobe, positive-displacement pump with a variable speed capability and remote control is the best choice (Metz, 1992).

## **The Laboratory**

The laboratory is the heart of the winery. This is where the winemaker gathers information, formulates decisions, directs responsibilities and records proceedings and data. A good laboratory is needed if quality control is to be maintained. Since the cost of some laboratory equipment can be prohibitive, a small winery may want to begin with the minimum

equipment (e.g. ebulliometer, pH meter, hydrometers, refractometers, glassware, etc.) for traditional and required analysis and examine the cost of having the Wines analyzed by a commercial laboratory before purchasing specialized equipment. The winemaker in a small winery usually becomes the liaison between the winery and the Bureau of Alcohol, Tobacco and Firearms (BATE). Usually, state and local regulations that are applicable to the small winery are also handled by the winemaker (Vine, 1981).

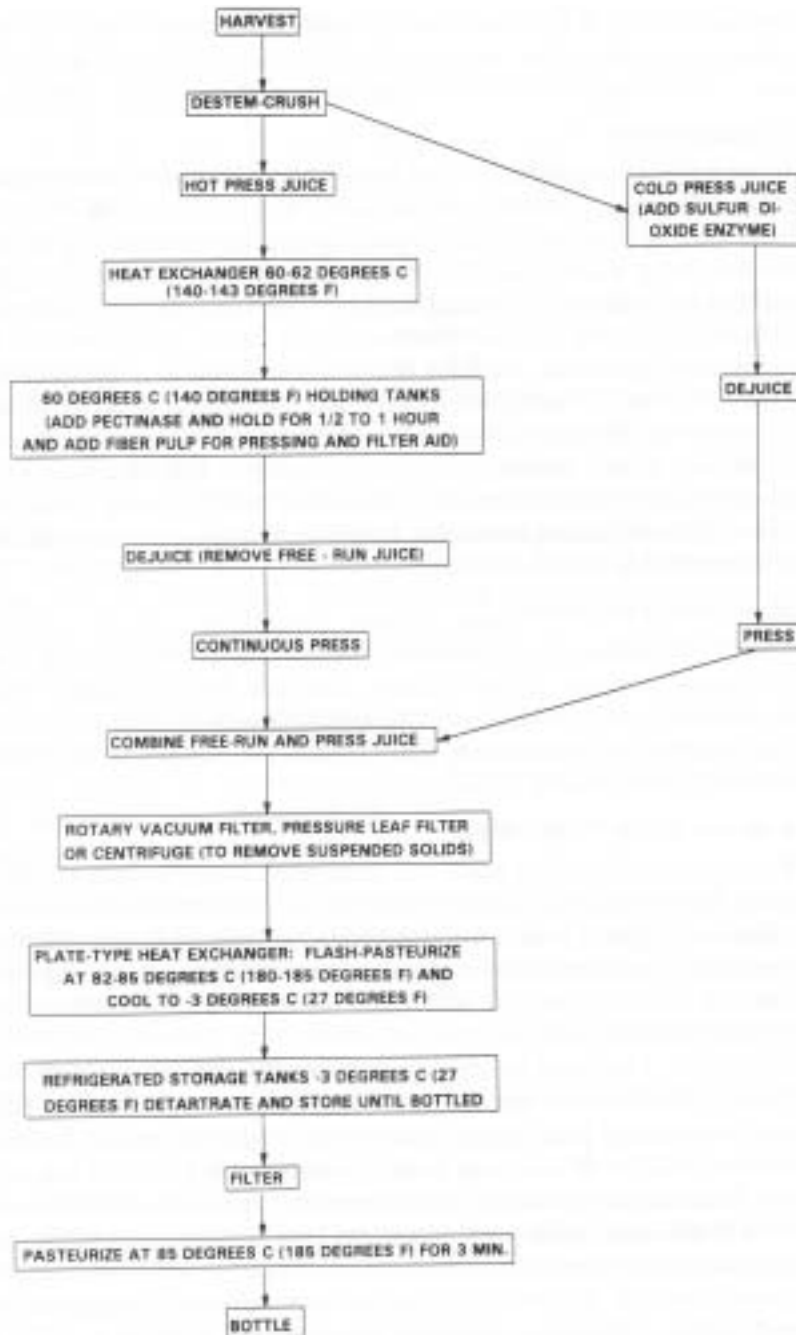


Fig. 2. The basic steps in producing grape juice.

## Grape Juice Production

The major preharvest and harvest conditions that influence the quality of grape juice are climate and soil, site and season, cultivar, vineyard management, maturity and harvesting method. Each of these factors exerts its own influence, but complex interactions among these factors can occur (Morris, 1987).

## Hot-press Juice Production

Figure 2 highlights hot-press and cold-press juice production stages that are explained in the following discussion. Methods for commercial preparation of grape juice have undergone continuous change. In most commercial operations, the hydraulic press has been replaced by a continuous pressing method. This press is not only more efficient but also more sanitary and allows less chance for fermentation before pasteurization. Hot-press juice production involves the use of a pectolytic enzyme to break down naturally occurring pectins and uses the addition of wood fiber, pulp or rice hulls to the crushed grapes to facilitate extraction of juice. A hot-press method yields more juice that contains higher total solids, nonsugar solids, tannins, pigments and other substances than a cold-press juice operation. In a hot-press operation, the temperature and time in processing can be varied within a range to produce juice with uniform color from grapes harvested throughout the harvest season. Excessive extraction temperatures must be avoided to preserve the juice quality (Sistrunk, 1976; Sistrunk and Morris, 1982, 1985). Commercially, temperatures exceeding 65 C (150 F) are to be avoided (Pederson, 1971).

The grapes are dumped into a hopper then transported by augers or pumps to a rotary stemmer-crusher that separates the fruit from the stem. The stems are discharged, and the crushed berries are pumped through a steam-jacketed, vacuum preheater where the pulp is heated to 60-63° C (140 to 145° F) and then passed into holding tanks. At this point slow-moving agitators in the tank mix approximately 91 g (0.2 lb) of pectolytic enzyme and 6.8 Kg (15 lb) of purified paper pulp into each ton of grapes. Within 30 min to 1 hr, the enzyme will break down the pectin to make the grape pulp ready for pressing.

In the next step, a dejuicer removes approximately 30 to 35% of the free-run juice through a 40-mesh screen. The remaining pulp is poured into a continuous screw press. The free run juice may have as much as 20 to 40% suspended solids while the pressed juice may have only 5 to 6% suspended solids. The two juices are combined, and a majority of the insoluble solids are removed by rotary vacuum filtration, pressure leaf filtration or centrifugation. This hot-press process yields approximately 738 L (195 gal) of juice per U.S. short ton of grapes.

An additional 37.8 L (10 gal) of juice (after concentration) may be obtained by breaking up the press cake, spraying it with hot water and re-pressing. After juice extraction the crude argols and tartrates must be precipitated. To accomplish this precipitation, the filtered juice is flash-heated at 80-85 °C (175-185 °F) in a tubular or plate-type heat exchanger, cooled in another heat exchanger to -2.2 °C (28 °F) and placed in tanks for rapid settling of argols. The final processing of the grape juice into single-strength juice or concentrate can occur anytime after the argols have settled and the juice has been racked off. The tank bottoms (sediment) can be filtered, reesterilized and stored to allow argols to again settle for optimal recovery of juice.

The juice is passed through a heat exchanger to bring the temperature to 77 °C (170 °F), into an automatic filler and then into preheated bottles. The full bottles are capped and pasteurized at 85 °C (185 °F) for 3 minutes. The bottles are then cooled and labeled.

Grape juice concentrate is made in much the same manner as any juice concentrate. Concentration of depectinized juice can be made to 72° Brix, but most grape juice is concentrated to 55°, 65° or 68° Brix. The volatile components are removed by heating the single-strength juice to approximately 110 °C (230 °F) for a fraction of a minute in a heat exchanger that flashes a percentage of the liquid into vapor in a jacketed table; then the liquid and vapor are discharged into a separator.

### **Cold-press Juice Production**

The only differences between this method of juice production and the hot-press method are the steps that allow for heating of the crushed berries to 60-63 °C (140-145 °F) and holding in tanks with pectolytic enzymes. Enzymes are added to the cold-press juice to facilitate the clarification and filtration process following cold stabilization. Juice yields from this method of processing may be only 165 to 175 gal/U.S. short ton, depending on the cultivar and pressing efficiency. Most small wineries have to use the cold-press method since they are not equipped for hot-pressing grapes.

### **THE ECONOMIC FRAMEWORK**

This study combines data from previous research, comments from personal interviews, survey responses and detailed equipment and price quotations from experts within the industry. These are used to study the economic environment under which winery and juice plant managers operate. The economic decision framework establishes guidelines to assist in the decision-making processes for improved profitability.

### **Data Used**

Data needed to define the economic decision-making framework include 1) wine and juice prices, 2) marketing limitations, 3) vineyard management and crush yield information, 4) equipment capacity and costs, 5) labor requirements and cost and 6) processing and miscellaneous costs. While the basic data utilized are discussed herein, a more detailed presentation can be found in Ward (1991). Expert opinion and unpublished data from Post (1992) and Metz (1992) were crucial in obtaining the data needed for the study.

### **Wine and Juice Prices**

A survey of Ozark region winery managers was used to determine wine prices for the wine production arrangements considered in this report. The resulting average wine prices per 750-ml (milliliter) bottle by varietal are shown in Table 2. Wholesale prices received by the winery are determined by discounting retail prices by 50% (wholesale price = 1/2 retail price), representing the price a winery will receive for selling to a wholesaler. This reflects a standard discount that will allow for a markup of 1/3 of cost for the wholesaler plus a retail level markup of 1/2 (wholesale price \* 4/3 for wholesaler \* 3/2 for retailer = retail price). Similar procedures were used for the sales of both pure grape juice and grape juice blends. However, instead of the price differentials that were included among the different varietal wines, all grape juices and blends were priced the same (Table 2).

**Table 2. Retail and wholesale wine and juice prices per 760-and bottle.**

Cultivar	Retail Price/750 ml	Wholesale Price/750 ml
	Dollars (\$)	
Chardonnay	7.85	3.93
Vignoles	7.50	3.75
Riesling	6.20	3.10
Vidal & Seyval	5.30	2.65
Niagara	4.10	2.05
<b>Average White</b>	<b>6.19</b>	<b>3.10</b>
Cabernet Sauvignon	9.00	4.50
Cynthiana	6.50	3.25
Chambourcin	6.00	3.00
Chancellor	5.00	2.50
<b>Average Red</b>	<b>6.63</b>	<b>3.33</b>
<b>Average Wine</b>	<b>6.38</b>	<b>3.19</b>
All Pure Grape Juice	3.00	1.50
All Blended Grape Juice	2.50	1.25

Note: Wine prices were determined from a survey of Ozark region winery managers.

### Marketing Limitations

While the sales of juice can commence upon completion of the first season's manufacture of juice, wine must undergo a proper aging process to satisfactorily complete the product. Consequently, the price of wine is further discounted using net present value techniques. The pattern and distribution of sales of the various wine varieties is illustrated in Table 3. This sales schedule, developed by expert opinion in the wine industry, enabled the net present value techniques to be utilized in calculating the discounted returns from wine sales when coupled with a discount rate of 10% using the following formula:

$$PV_c = \sum_{y=1}^6 (P_c W_{yc}) / (1+d)^y$$

Where:  $PV_c$  - present value price of wine by varietal grape

$P_c$  - retail price for wine c (Table 2)

$W_{yc}$  - weight of sales for year y for wine c (e.g., .50 for year 3 for Chardonnay) from Table 3

d - discount rate (0.10)

**Table 3. Sales schedule of wine production by cultivar and year.**

Cultivar	Years in which year 1 is production					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
	Sales in percentage (%)					
Chardonnay	0	0	50	25	25	NA*
Vignoles	0	50	25	25	NA*	NA*
Vidal & Seyval	0	50	25	25	NA*	NA*
Riesling	0	50	25	25	NA*	NA*
Niagara	0	50	25	25	NA*	NA*
Cabernet Sauvignon	0	0	0	50	25	25
Cynthiana	0	0	0	50	25	25
Chambourcin	0	0	50	25	25	NA*
Chancellor	0	0	50	25	25	NA*

\*NA means not applicable. In this study, wines are sold on a four-, five- or six-year cycle. For example, Vignoles, Vidal, Seyval, Riesling and Niagara are sold on a four-year cycle with 50% sold in year 2, 25% in year 3 and the remaining 25% sold in year 4. Sales begin in either the second, third or fourth season after the grapes are produced, harvested and crushed and the winemaking process is initiated.

The resulting discounted wine prices are presented in Table 4. A winery manager would find these to be a more accurate price to compare to production costs to estimate net returns per bottle because the costs are realized today but the wine must be aged and the wine will not be sold by the winery for several years.

Quantity of grapes required is dependent upon the type of processing activity. Product conversion from raw material is as follows: red and white wine -165 gal/ton of grapes; hot-press juice - 190 gal/ton; and cold-press juice - 155 gal/ton.

**Table 4. Retail and wholesale discounted wine prices per 750-ml bottle.**

Cultivar	Retail Price/750 ml-	Wholesale Price/750 ml
	dollars (\$)	
Chardonnay	6.03	3.03
Vignoles	6.37	3.18
Riesling	5.26	2.63
Vidal & Seyval	4.50	2.25
Niagara	3.48	1.74
Average White	5.13	2.57
Cabernet Sauvignon	6.31	3.16
Cynthiana	4.56	2.28
Chambourcin	4.63	2.32
Chancellor	3.86	1.93
Average Red	4.84	2.42
Average Wine	5.00	2.50

Note: Wine prices were determined from a survey of Ozark region winery managers.

Prices for wine and juice (Table 2) reflect a high-traffic situation in which the operator of the winery and juice plant encourages customer flow-through, has a good location and also has a desirable, adequate selection of varieties. With one or more of these characteristics lacking, wine prices would probably be higher. Consequently, a winery cannot usually expect to sell wine beyond maximum and minimum percentages of individual varieties within the total blend of products sold. The resultant maximum and minimum sales of wine varieties and juice as a percentage of total sales volume in gallons are given in Table 5; the sales were based upon a 1991 survey conducted among winery managers in the Ozark region. The assumed maximum retail sales volume percentages and total juice volume for the various winery sizes are given in Table 6.

#### **Equipment Capacity and Costs**

In evaluating the economics of winery equipment, many issues arise. The first addressed herein is how much labor and equipment time is required to perform the various processes. The weekly requirements in minutes/gallon are presented in Table 7 for labor and equipment for the various processing activities. Base information used for calculating these requirements was taken from Ward (1991). The equipment depreciation cost by type and capacity level is presented in Table 8 (using straight line techniques and expert opinion on useful life). Table 9 displays weekly capacity rates for the various types of equipment and the annual capacity categories used. Equipment data were obtained from Metz (1992). Several qualitative issues arise in explaining the desire of a winery to invest in larger equipment (Price et al., 1993). It should also be noted that annual capacities for some factors are the same as weekly capacities such as barrels. Additional details can be found in Dillon et al. (1992b) and Ward (1991).

**Table 5. Maximum and minimum sales of varietal wines as a percentage of total sales volume in gallons.**

Varietal wines	Minimum	Maximum
Chardonnay	2.5	10.0
Vignoles	10.0	20.0
Riesling	2.5	10.0
Vidal & Seyval	7.5	60.0
Niagara	2.5	10.0
Cabernet Sauvignon	2.5	10.0
Cynthiana	2.5	10.0
Chambourcin	5.0	20.0
Chancellor	2.5	10.0
Concord	0.0	20.0

Note: Marketing percentages were determined from a survey of Ozark region winery managers. Different marketing conditions will prevail dependent on individual circumstances.

**Table 6. Maximum wine and juice retail percentages and maximum juice sales volume by equipment capacity.**

Winery Size Gallons	Maximum Wine & Juice Retail % of total volume	Maximum Juice Sales Gallons
100,000	22	5000
80,000	25	4000
40,000	40	2000
20,000	65	1000
10,000	100	500
5,000	100	250

**Table 7. Wine and juice weekly labor and equipment requirements in minutes/gallon.**

Process	Winery size <sup>z</sup>	Week					
		1 <sup>y</sup>	2	3	4	5	6
White Wine	5	0.929	0.006	0.006	0.006	0.006	0.006
Red Wine	5	0.935	0.012	0.012	0	0	0
Juice	5	1.920	0	0	0	0	0
White Wine	10	0.215	0.009	0.009	0.009	0.009	0.009
Red Wine	10	0.214	0.018	0.018	0	0	0
Juice	10	1.200	0	0	0	0	0
White Wine	20	0.130	0.006	0.006	0.006	0.006	0.006
Red Wine	20	0.138	0.117	0	0	0	0
Juice	20	1.120	0	0	0	0	0
White Wine	40	0.102	0.009	0.009	0.009	0.009	0.009
Red Wine	40	0.107	0.018	0.018	0	0	0
Juice	40	0.297	0	0	0	0	0
White Wine	80	0.065	0.009	0.009	0.009	0.009	0.009
Red Wine	80	0.074	0.018	0	0	0	0
Juice	80	0.256	0	0	0	0	0
White Wine	100	0.064	0.008	0.008	0.008	0.008	0.008
Red Wine	100	0.072	0.016	0.016	0	0	0
Juice	100	0.156	0	0	0	0	0

<sup>z</sup>Winery size is in thousand gallons of fermenting capacity annually.

<sup>y</sup>Production begins in week one for the purpose of this table. As an example, it does not imply that juice may be made only in week one.

Capital or monetary investment requirements for equipment, buildings and non-vineyard land are displayed in Table 10. When corrected for differences in assumed inflation rates and capacity terminology, capital requirements are similar to those in Folwell and Castaldi (1987). Winery construction can range from insulated metal buildings to an elaborate, aesthetically beautiful stone structure, depending on image desired and capital available. This study assumes selection of a minimum-cost winery building equipped with the most modern winemaking equipment. Appendix I provides a detailed presentation of specific equipment and capital requirements for each capacity level.

**Table 8. Equipment depreciation costs by type and capacity.**

Equipment Type	Winery size (annual capacity in thousand gallons)					
	100	80	40	20	10	5
Receiving/Crushing	6501	6484	3595	3300	1123	746
Cellar/Fermenting	14950	14950	8363	4241	3667	789
Fermenting & Storage Tanks	11384	10493	5929	4225	2509	1880
Bottling	8676	7826	7486	5236	936	371
Barrels	80100	64080	32040	16020	7967	4007
Refrigeration	2750	2750	2000	2000	1000	0
Small Heat Exchanger	417	300	300	183	183	183
Large Heat Exchanger	1250	900	900	550	550	550
Boiler	2000	2000	1333	1333	667	667

**Table 9. Weekly capacity rates of equipment by type and capacity in gallons per week.**

Equipment Type	Winery size (annual capacity in thousand gallons)					
	100	80	40	20	10	5
Receiving/Crushing	140000	140000	85555	62222	31111	5833
Cellar/Fermenting	105000	84000	84000	52500	52500	58800
Fermenting & Storage Tanks	133150	108350	56050	28450	14450	6950
Bottling	87500	87500	52500	52500	24500	24500
Barrels	245455	196364	98192	49091	24545	12273
Refrigeration	100000	80000	40000	20000	10000	5000
Small Heat Exchanger	24000	12000	12000	2400	2400	2400
Large Heat Exchanger	24000	12000	12000	2400	2400	2400
Boiler	100000	80000	40000	20000	10000	5000

### Vineyard Management and Crush Yield

Grape production data, such as grape prices, grape yields, grape production costs, harvest costs and similar information, are obtained from published estimates (Kirchner et al., 1988) and updated when possible by recent survey data. In order to reflect the perennial nature of grapes, weighted averages from the entire expected life of the vineyard are investigated. Consequently, averages weighted by wine grape maturity stage for production costs and yields are presented in Table 11. Following Kirchner et al. (1988), a 30-year life span is assumed for the vineyard, and the average yields and production costs are calculated, including initial years of establishment with no yield occurring. Table 11 further presents estimates of the custom harvest rates assumed per ton for various grape varieties. The winery and juice plant manager has the option of purchasing grapes rather than producing them. In such a case, the purchase prices presented in Table 11 may be helpful.

**Table 10. Capital requirements by equipment type and winery size.**

Item	Winery size (annual capacity in thousand gallons)					
	100	80	40	20	10	5
<b>EQUIPMENT<sup>y</sup></b>	<b>Dollars (\$)</b>					
Receiving & Crushing	130015	129675	71905	65990	22455	14920
Cellar	119600	119600	66900	33925	29335	6310
Bottling	173520	156520	149720	104720	18720	7420
Tanks	227670	209860	118570	84500	50180	37600
Refrigeration	55000	55000	40000	40000	20000	0
Barrels	240300	192240	96120	48060	23900	12020
<b>TOTAL WINE EQUIPMENT</b>	<b>946105</b>	<b>862895</b>	<b>543215</b>	<b>377195</b>	<b>164590</b>	<b>78270</b>
Boiler	30000	30000	20000	20000	10000	10000
Large Heat Exchanger	18750	13500	13500	8250	8250	8250
Small Heat Exchanger	6250	4500	4500	2750	2750	2750
<b>TOTAL JUICE EQUIPMENT</b>	<b>55000</b>	<b>48000</b>	<b>38000</b>	<b>31000</b>	<b>21000</b>	<b>21000</b>
<b>TOTAL WINE &amp; JUICE CAPITAL</b>	<b>1001105</b>	<b>910895</b>	<b>581215</b>	<b>408195</b>	<b>185590</b>	<b>99270</b>
Buildings & nonvineyard land	1049000	784000	434000	224000	124000	74000
<b>TOTAL (EQUIPMENT &amp; BUILDINGS)</b>	<b>2050105</b>	<b>1694895</b>	<b>1015215</b>	<b>632195</b>	<b>309590</b>	<b>173270</b>
SQ FT	40000	29400	15400	8400	4400	2400
CAPITAL/SQ FT	51.25	57.65	65.92	75.26	70.36	72.20

<sup>y</sup>Equipment capital requirements are taken from Ward, 1991.

### Labor Requirement and Costs

The labor time involved in winemaking processes paralleled the equipment times given in Table 7. Salaries for personnel based on expert opinion and survey results are given in Table 12. Full-time employee positions required for the different winery sizes are listed in Table 12 Section I. The estimated total number of employee positions ranges from two persons for a 5,000-gallon winery to a total of 13 at the 100,000-gallon winery. The winemaker and cellar worker positions are required at all levels. At the 10,000-gallon winery size, the need for a retailer and a general laborer arises as a result of the volume being marketed. At the 40,000-gallon level, an additional person is also levels projected for the skilled positions. The total annual payroll for full-time employees ranges from \$39,000 for the 5,000-gallon winery up to \$224,000 for the 100,000-gallon winery.

**Table 11. Weighted average production costs, yields, purchase prices and custom harvest costs for grapes by cultivar.**

Cultivar	Yield tons/acre	Purchase Price \$/ton	Production Cost \$/acre	Custom Harvest Rate \$/ton
Chardonnay	4.0797	1000	2042.92	80
Vignoles	4.5281	500	1791.35	35
Vidal-Seyval	4.9194	400	1679.19	35
Riesling	4.8731	600	2226.99	80
Niagara	6.5097	250	1522.51	35
Cabernet Sauvignon	4.0797	850	2119.78	80
Cynthiana	3.6467	650	1530.27	35
Chambourcin	5.7294	400	1770.28	35
Chancellor	5.7294	350	1808.70	35
Concord	6.0296	200	1529.77	31

Table 12. Full-time employees by position and winery size.

#### Section I. Number of persons required per year

Position	Winery size (annual capacity in thousand gallons)					
	100	80	40	20	10	5
	<u>Number of persons in each position----</u>					
WineMaker	1	1	1	1	1	1
Retailer	4	3	2	1	1	0
Cellar Worker	2	2	1	1	1	1
Marketing & Delivery	2	2	1	0	0	0
Laborer	4	3	3	3	1	0
Total Employee Positions	13	11	8	6	4	2

#### **Section II. Full-time employee salaries per person in dollars per year.**

##### Winery size (annual capacity in thousand gallons)

Position	100	80	40	20	10	5
	Dollars (\$)--					
WineMaker	30,000	30,000	25,000	25,000	25,000	25,000
Retailer	18,500	18,500	18,500	18,500	18,500	18,500
Cellar worker	20,000	20,000	18,500	18,500	18,500	14,000
Marketing & Delivery	20,000	20,000	18,500	18,500	18,500	18,500
Laborer	10,000	10,000	10,000	10,000	10,600	10,000
Total Employee Salaries	224,000	195,500	129,000	92,000	72,000	39,000

Note: Labor needs are taken from Ward, 1991.

\*Calculated by Section I' Section II or number of employees multiplied by position salary.

### Processing and Miscellaneous Costs

The processing costs and miscellaneous costs make up the remaining data requirements to be discussed. As presented in Table 13, the costs for bottles, corks, labels, yeast, utility expenses and wine taxes range from \$0.71 to \$0.74/gallon. Other miscellaneous costs are shown in Table 14.

### CONCLUDING COMMENTS

In conclusion, the economic decision-making process is intricately linked to the fundamental foundations of the technological framework. Guidelines that may be helpful in improving profitability were discussed. Focus upon marketing, production and financial management can be very rewarding in terms of improving the economic success of the winery. Careful attention to management cannot be overemphasized. Planning, control and implementation are three key elements of successful management. If any principle should be stressed in this study, it is that it is important to develop a good plan that will achieve the business objectives. Secondly, it is imperative that the performance of the business towards achieving established goals and objectives be monitored. If one does not have an established set of goals and monitor progress, the success of any business operation cannot be adequately measured. Finally, implementation is crucial. The reader of this publication should remember that the data presented in this study are not meant to be applied to all situations. The publication is intended to provide general guidelines through examination of a basic, representative situation.

**Table 13. Processing costs for wine and juice by item in dollars per 760-ml bottle.**

Item	Winery size (annual capacity in thousand gallons)					
	100	80	40	20	10	5
Glass Bottles	0.340	0.340	0.340	0.340	0.340	0.340
Corks	0.070	0.070	0.070	0.070	0.070	0.070
Capsules	0.032	0.032	0.032	0.032	0.032	0.032
Labels	0.070	0.070	0.070	0.070	0.070	0.070
Yeast	0.005	0.005	0.005	0.006	0.021	0.021
Utility Expenses	0.002	0.003	0.004	0.007	0.010	0.016
BATF Taxes <sup>2</sup>	0.188	0.188	0.188	0.188	0.188	0.188
Total Selected						
Costs	0.707	0.707	0.709	0.714	0.731	0.737

<sup>2</sup>BATF refers to Bureau of Alcohol, Tobacco and Firearms but also includes Arkansas state taxes. Other state tax structures may be found in Wines and Vines, 1991 Buyer's Guide.

**Table 14. Miscellaneous costs.**

Item	Percent	Base
building insurance	1.00	Building Capital Outlay (Value)
Equipment insurance	1.00	Equipment Capital Outlay (Value)
Property taxes	1.00	Property Value
Advertising	5.00	Total Gross Sales
Repairs and maintenance	1.50	Capital Outlay (Value)
Office supplies	1.00	Total Gross Sales
Accounting expenses	1.00	Total Gross Sales
Building depreciation	6.67	Building Capital Outlay (Value)
Fringe benefits	12.65	Total Salaries
Interest rate	12.00	Amount Debt or Equity Capital Needed
Excise taxes	3.00	Total Wine Sales

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## GLOSSARY

- 2,4,6-trichloroanisole** - compound responsible for the corky odor "cork taint" found in approximately 3% of corked wines. This compound, detectable at four parts per trillion, is sometimes produced during cord production, storage and transport.
- Accounting profits** - dollar value remaining after all operating (e.g., glass bottles, corks) and fixed expenses (e.g., land interest payments or depreciation) have been deducted from revenues (but disregarding opportunity costs).
- Activity coefficient** - a number representing a relationship in a mathematical programming model such as grape yield per acre or minutes of labor required to crush.
- Anaerobic reaction** - any reaction that occurs in the absence of oxygen.
- Argols** - tartar in its crude form as deposited in wine casks.
- Aroma** - that portion of the smell of a wine derived specifically from the grape as opposed to the portion of the smell derived from other sources (see *Bouquet*).
- Astringency** - a physical sensation that occurs in the mouth upon tasting that is characterized by shriveling of the mouth's tissues.
- Average total cost per gallon** - total cost divided by the number of gallons produced.
- Base case maximum** - the greatest potential profit of the economic model for the typical situation before sensitivity analysis.
- Batch press** - press that presses one lot at a time as opposed to a continuous press.
- Bouquet** - the odor a wine has that derives from the fermentation process, from the aging-in-wood and bottle process and other changes independent of the grape variety used. Bouquet is used to describe all non-varietal smells in wine.
- Brix** - a hydrometer scale used to measure dissolved solids (primarily sugar) in grape juice.
- Canopy** - the cover of vegetation of vine formed by its leaves, branches, etc.
- Cap** - the floating mass of skins and pulp at the top of a fermentation vessel that occurs during fermentation.
- Capital investment** - value of resources used to purchase the equipment, buildings and land for the winery.
- Clarify** - the addition of agents to a wine in order to precipitate insoluble solids or suspended materials. Also, wine will clarify during cold stabilization.
- Cold-press** - a process in which grapes are pressed directly after crushing or as whole clusters.
- Cuvee** - French for "tank"; a blend of wines, either of the same or different vintages, prepared for secondary fermentation into sparkling wines.
- Decanting** - the operation of delicately transferring wine from one bottle to another to separate any sediment formed in the first bottle.
- Depreciation** - a noncash expense that reflects the loss in value of an asset due to use, age and obsolescence.
- Economic profits** - dollar value remaining after all operating and fixed expenses as well as expected return to personal owner labor, capital, etc. (opportunity costs) have been deducted from revenue.
- Enology** - the art, science and study of making wine.
- Enzymatic oxidation** - oxidation and browning caused by enzyme activity.

**Fermentation** - the process by which yeast converts sugar to alcohol and CO<sub>2</sub>

**Filtration** - the act of passing a wine through a filter medium to remove suspended solids, yeast and/or bacteria cells.

**Fining** - the application of specific agents to clarify and stabilize wines.

**Fixed costs** - expenses incurred that do not vary with production level (e.g., interest payments on land and capital, property taxes).

**Free-run juice** - the portion of juice that flows by gravity from a holding tank into a receptacle after the fruit is crushed.

**Gas sparging** - bubbling an inert gas (N<sub>2</sub> or CO<sub>2</sub>) through juice or wine to reduce oxygen gas.

**Grape cultivar** - a cultivated variety of grapes.

**Gross revenue** - the total dollar amount of all sales before expenses are subtracted out.

**Hard press juice** - juice that comes from the areas of the grape berry near the seeds and skins. This juice requires higher pressures to remove and contains high levels of phenols and proteins as compared to free run juice.

**Hot-press** - a process in which grapes are pressed after heating and enzyme treatment.

**Insoluble solids** - compounds in juice and wine that don't dissolve but precipitate.

**Lees** - the sediment that precipitates from young wines during and after fermentation.

**Long-run equilibrium situation** - scenario after initial establishment of a business with no economic forces inducing change.

**Maceration** - the process of breaking down the grape in the presence of liquids.

**Maximum absolute quantities** - greatest economically feasible output potential.

**Must** - crushed grapes that have been destemmed.

**Mute** - a fruity flavored juice added back to wine for flavor enhancement.

**Negative profit** - loss from operation and sales; when total costs exceed gross revenue.

**Net returns** - gross revenue less expenses or profit.

**Off-flavors** - any flavor that is detrimental and unintended for the wine.

**Operating costs** - variable costs.

**Opportunity cost** - value of employing identical resources in alternative uses (for example, investing in stocks and bonds rather than a winery).

**Pectins** - a water-soluble carbohydrate from fruit that yields a gel.

**Phenolics** - a group of compounds having a phenolic ring structure that are found in grapes. These compounds are responsible for color, aroma and astringency in wine.

**Pomace** - pressed seeds and skins that remain in the press after the juice or wine has been removed.

**Profit function** - the underlying relationship determining how profit is influenced by managerial decisions (such as the amount of variable inputs to use).

**Pumping over the cap** - a process in which the cap is submerged. This is done either by pumping fermenting must over the cap to submerge it or by physically pressing the cap down. This process is done two to three times a day and is necessary to fully extract the color from the skins and to prevent unwanted microbial growth.

**Pump, non-positive displacement** - a pump that does not necessarily discharge the same amount of fluid per cycle, such as a centrifugal pump.

**Pump, positive displacement** - a pump that discharges the same quantity of fluid per cycle, such as a piston pump.

**Rack** - to transfer wine from one vessel to another, usually by siphoning or pumping.

**Rate of return above interest** - net returns (with interest expense subtracted out) divided by capital requirements.

**Rate of return to capital** - returns to capital (net returns plus interest expense) divided by total assets and expressed as a percentage.

**Sensitivity analysis** - experimentation to determine the change in profits and business decisions in response to alterations in prices, marketing conditions or other factors.

**Sparging** - see gas sparging.

**Sulfur dioxide** - SO<sub>2</sub> - widely used preservative to keep wine from browning or spoiling. SO<sub>2</sub> properly used will suppress wild yeast growth.

**Tannins** - special phenolic compounds found in grape stems, seeds and skins that contribute to astringency and bitterness.

**Tartrates** - natural tartaric acid crystals that precipitate in wine stored at cold temperature. The crystals that form are the acid salt of potassium bitartrate (cream of tartar).

**Total costs** - the sum of variable costs and fixed costs.

**Variable costs** - those costs that fluctuate directly with level of operation of firm (e.g., glass bottles, labels, fertilizer used in grape production).

**Varietal wines** - term used to describe a wine made 75% from the juice of one cultivar or variety of wine grape.

**Weighted averages** - as used in this report, average grape yields and production costs reflecting the 30 year life of the vineyard (e.g., no yields for the first two years, reduced yields for years three and four and full yields for years 5-30).