



Crop Management in Wine Vineyards



I'm pretty sure that crop estimating is something academic viticulturists like me talk about each year but growers almost always ignore. Growers are not statisticians and generally don't do a good job of keeping records. There's always a ready excuse like spraying or mowing for not counting or weighing clusters. But I keep talking about it because I was once a grower and crop estimating really helped me! It is one job that can improve both your understanding of the vineyard, business and grape quality. Before you even make an estimate, sit down and figure out why you are estimating and what

your objectives are for the vineyard and wine. Crop management, along with canopy management, are two of the most important viticulture practices growers can use during the current growing season to influence wine quality. For that reason make sure you include the wine maker any decisions regarding crop levels For this paper, I am assuming that our goal is grow the highest quality grapes possible.

In general, red varieties are more finicky than whites when it comes to wine making. Whites can often make good wine over a wider range of ripeness so getting to just the right level of maturity isn't quite as demanding. The quality of red wines, and especially varieties like Cabernet Franc and Pinot Noir, are very sensitive to crop load. For example, in Oregon our target for Pinot Noir was +/- 500 lbs on either side of 2.5 ton/acre (t/a) to achieve optimal quality. Too much crop dilutes the wine, too little hurts the bottom line. This seems like a big target but it was always a challenge to hit in a cool climate region where so many things can alter yield during the year.

Viticulture researchers and extension educators tell us that the optimal yield for quality is 5:10 lbs of fruit per pound of pruning weights. That's a big range! Vine balance resides somewhere within these boundaries – the harmonious balance between foliage and fruit. Normally we can expect *vinifera* varieties (especially reds) to be at the low end and hybrids (especially whites) and natives to reside among the higher yields. The other formula we are given is the ideal balance between leaf surface area (canopy/vegetative growth) and crop yield, 15 cm²/gram of fruit. Of course, no one but the graduate students who were forced to actually determine this ratio really understands what it means or can imagine what it looks like in the field. Suffice to say there is a balance on each vine between leaves and fruit that will produce the best possible wine and it's up to each grower to figure out what that is for each variety/clone in each block of grapes. Ideally, careful site selection, evaluation, design and development will result in a vineyard with optimal balance and yields but in the absence of this situation, growers must perform yield experiments to determine what the idea crop load for each distinct portion of vineyard. It's easy to say Pinot Noir makes the best wine at 2 t/a, but on your site, does it?

The method of choice for most novice growers (and too many experienced ones) is to guess crop size. This is not a satisfactory method because it relies more on luck than skill to achieve an accurate result. Gazing at clusters from the tractor seat while spraying is not a crop estimation method. Instead, a statistics-based system is the best way to gauge crop size, if for no other reason than you can explain to a winemaker why the load of grapes you are delivering to the winery is 50% over or under the figure you gave him earlier in the year. Later, after many years of experience, a grower may be able to estimate crop visually, but even experience has its lapses. There is too much at stake financially and in wine quality not to back up a visual estimate with field data.

Crop management begins with balance pruning vines in the winter. Whether you are doing this by cutting canes just long enough to fill the trellis between vines or weighing pruning weights, you are establishing the foundation for this year's crop. As much as growers wish for consistent yields from year to year in cool/cold climate regions there are many reasons why crop should be estimated each year. Unless bud initiation is particularly fruitful and more clusters appear than expected, the crop is slowly whittled down during the season for a variety of reasons. Some are viticultural decisions such as shoot thinning and crop thinning. Others are accidental such as a hedger or leaf remover. And many are environmental such as winter injury, spring frost, wind, hail, poor bud initiation, poor fruit set, diseases, birds, deer, etc, have a variable impact on yields each year, usually more so than in warmer, drier wine regions. So this really needs to be an annual practice in the East.

Crop estimates are important for a variety of reasons, both to the vintner and the grower. Growers are concerned with producing high quality fruit so that they can get the highest price possible for their grapes. Ideally the grower wants to achieve maximum production AND optimal quality. Practical considerations influenced by crop load include harvest costs and logistics, such as trucking, picking payroll and timing of the harvest. Crop load can also affect vine health. Overcropping a vine has many well documented negative impacts on fruit and vine quality including reduced and delayed fruit ripening, potential vine stress that may lead to increased susceptibility to winter injury, disease problems especially late season rots and other significant problems. Undercropping can also affect wine quality as well as cheat you of valuable revenue.

Wineries need to know how many grapes they will be expected to process in a vintage. This affects their logistics, from tank and barrel space to scheduling of grapes. It also impacts their finances – both in terms of the amount of grapes they expect to pay for, and the amount of wine they will produce and sell. Growers need to be sensitive to these winery issues.

For each block of grapes in the vineyard, the grower should have an idea of a target yield based on vineyard performance and the desired wine style and price point. The wine maker must be intimately involved in these decisions. Setting target yields may be difficult in young vineyards, but as the vines mature, it is possible to predict the crop load the vines will ripen. We all dream of a vineyard with consistent yields from year to year, but in fact, this is rarely the case. In any given year, many factors can affect yields. These include poor weather at set, nutrient imbalances, disease, birds, deer, poor thinning quality and many more, both within and outside of our control. As growers, we strive to achieve a crop load, in the framework of a particular season that will achieve our quality goals.

The timing of crop estimate and adjustments is a much debated issue. When is the best time to thin a crop if it is too heavy? In Oregon, where I grew grapes for 16 years, we performed lag phase estimates and thinned about halfway between bloom and veraison. Many people are doing estimates and thinning earlier – right after fruit set – believing that this produces riper and more intense fruit. The French argue that this just causes berry size to increase. I will adhere to the lag phase thinning formula, if only because it was successful for me and is the method I am most familiar with. You may wish to experiment with timing in your own vineyard.

Lag phase is that period in a berry's development when it takes a bit of a rest. After fruit set, cell division is responsible for the berry's increase in size. About 55 days after first bloom (others report from 30-40 days after bloom) occurs, the berries enter a quiescent phase for about 10 days, before they begin their final push into veraison and on to final size and ripeness. Lag phase is indicated by a hardening of the seed coat. At this moment, the sharp blade of a pocket knife will encounter significant resistance when cutting through the seed. It was determined by Dr. Porter Lombard, a viticulturist at Oregon State University, that at this point in time, the berry has achieved approximately half its final harvest weight. Since crop estimates are all about predicting weights, this fact is both consistent and measurable, and it becomes an invaluable tool for estimating harvest yields. Take your cluster samples at 90% seed hardening.

Doing crop estimates is hard and tedious work which is probably why so few growers do it. But the information it provides is valuable and it's a chance to get into your vines and get to know them very well two times during the growing season. It is necessary to get a count of the average number of clusters on each vine. This can be done as soon as the flower clusters appear on shoots in the spring. They are much easier to see and count early in the season. Reliable cluster counts are vital to crop estimate accuracy. Do not count second crop.

No commercial grower is going to sample each vine. Therefore, we must adhere to certain principles of statistical analysis that will enhance accuracy. Sampling is all about reducing the amount of error in the sample, which calls for consistency and accuracy. It is also important to achieve a truly random sample. Fortunately, we have the ideal crop for random sample. Because it is laid out on a grid system, grape growers can sample according to a prearranged pattern that will remove any personal bias from the selection process (growers tend to pick dark and big clusters). My method was to walk down a row and, without looking, stick my hand into the vine and grab a cluster (some bee stings resulted from this technique). Or, if you are nerdy statistical type, you can pick the apical cluster on the third shoot from every tenth vine. Sample as large a segment of the population as you can tolerate to increase accuracy. Lacking statisticians there is surprisingly little agreement on the optimal sample size, per acre, per number of vines or any other measure. If you have a small vineyard of just a few hundred vines, you will want to sample about five to ten vines. Dr. Terry Bates at Cornell University recommends that growers sample 1/100th of the vineyard field for mechanical sampling, this may be too much for hand sampling. Steven Price recommends 4% of vines for small vineyards, even lower percent for larger vineyards as long as they are uniform. As uniformity decreases, sample number should increase to reflect variations.

To reduce sampling error, may I suggest that you always have the same person do the data collection, and that the same grid pattern be used. Avoid outside rows and end vines. Estimated blocks should be as uniform as possible – for example, you cannot accurately estimate combinations of trellis systems such as VSP and GDC. Margins of error in sampling are small. A few grams here, a couple of missing vines there – they all add up to sampling error and of your calculations will balloon to tons per acre off the mark. Be meticulous.

Sampling clusters can be done either by stripping crop from an entire vine, or randomly removing clusters from numerous vines. Count the clusters, put them in a container, zero out the scale and get the average weight of each cluster, or weigh individual clusters (I found weighing in grams on an analog scale the converting to ounces to be easier). After fruit set it becomes easy to see if the clusters were affected by inflorescence necrosis, coulure or other fruit set maladies which will affect the results of your estimates.

Information you need to collect for an accurate crop estimate include:

1. Vines per acre (real count, not an estimate)
2. Acres in a block or field
3. Average clusters per vine
4. Average cluster weights at lag phase
5. Multiplier for each variety
6. Target yield in tons per acre or pounds per vine

Knowing the number of vines per acre is critical to an accurate estimate. If there are many vines missing in your field, it will affect your accuracy. Please be sure to account for this variation. The multiplier is also important to accuracy. The number generally used at lag phase is 2, but this can vary according to the season, site, variety, clone and other factors. The best thing to do is to start with 2 and make adjustments over time, based on your experience with each variety and vineyard section. At the Hogue Cellars in Washington, they have developed multipliers for specific phenological stages of berry development from pea size berries to veraison (80% of full size). Concord yields are based on crop estimates at 1200 growing degree days. So there are plenty of opportunities to take mid-season samples.

The math is easy: clusters per vine x vines per acre x lag phase cluster weight x multiplier = yield per acre

Example: Cabernet Franc planted on 8'x5' spacing (1089 vines/ac), shoot thinned to 3 shoots per foot of trellis with 2 clusters per shoot.

30 clusters/vine x 1089 vines x 0.17 lb average lag phase cluster weight x 2 multiplier = 11,000 lb/ac or 5.5 t/a

If your target yield is at or below your estimated yield you can relax, not fruit thinning is needed. But if your target yield is below your predicted yield, there is another step: subtract your target tons per acre from your predicted yield to get the amount of fruit per acre that must be thinned. To get to clusters per vine...

Example: if your target for Cabernet Franc is 4 t/a, and your estimate shows you have 5.5 t/a then you need to remove 1.5 t/a.

- a. $1.5 \text{ t/a} \times 2000 \text{ lb/t} = 3000 \text{ lbs}$
- b. $3000 \text{ lb}/1089 \text{ vines/ac} = 2.75 \text{ lb/vine}$ needs to be removed
- c. $2.75 \text{ lb/vine}/0.34 \text{ lb harvest cluster weight} = 8 \text{ clusters}$

Remove eight clusters per vine or four clusters per side of a bilateral vine.

This example is in pounds. Be sure to convert all your units correctly throughout these calculations. Using simple algebra you can calculate in all different directions with these figures. I highly recommend that you read Steve Price's original article in *Practical Winery and Vineyard* about predicting yields (find it at <http://pawinegrape.com/>).

This is remarkably easy to do but it takes time and attention to detail. Not surprisingly, being off by just a teensy-weensy bit on lag phase cluster weight, cluster number or vines per acre can dramatically shift the results either up or down. That's why it is so important to have accurate sample numbers and vine counts. Obviously, the multiplier is important to accuracy. This usually comes with experience.

Keep careful records of your lag phase weights and compare them later with your harvest data as a check for accuracy.

Tons per acre are the common currency for discussing vineyard yields but pounds per vine may provide more accurate indication of the capacity of the vineyard. Yield per vine is closely correlated to vine size and balance, which is related to site capacity and the vine spacing that was assigned to the vineyard.

Now that you have your tons per acre, or pounds per vine, you can decide if you want to reduce the crop or add more to the vines. I suggest you consult with the wine makers at this point. Adding crop to the vines is complicated, labor intensive and involves specialized equipment, such as a hot glue gun, long extension cords and many trips to the produce section of your grocery store.



Thinning is a very subjective exercise, which makes it particular difficult and sometimes dangerous to explain to a vineyard crew. Thinning with accuracy may be more a matter of luck than skill, but you will get better with experience. After you have figured out how many clusters per vine you want to eliminate, remove the apical cluster on a shoot and an equal number of clusters on each side of the vine. Remove clusters that are touching or in crowded areas and try to balance cluster distribution in the fruit zone. Some judgment is involved – vigorous vines may require less thinning, weak vines more crop removal. It's hard to instruct

other to do this, especially if a language barrier is involved. In my first years of doing this, we never got close to the right crop level and our harvest weights were always too high. I figured out that our crew was reluctant to cut grapes off because that was literally their money at harvest time. Follow your crew closely and look not only at the fruit on the vine but also at the number and size of the clusters on the ground. We all have a sense of how a proper crop load looks when it is hanging on a vine – try to resist intuition and stick with the numbers. I remember the first time the vineyard owner saw all the fruit on the ground and thought I had lost my mind! Be prepared with an explanation of the crop yield quality relationship. It might help to have some evidence to support your decision to thin.

In some wine areas growing high quality red wines crop adjustment begins by thinning to one cluster per shoot and fruit quality is closely monitored to determine if further thinning is necessary. As a rule, the closer you get to veraison, the less physiological impact removing fruit has on quality. That said, continuing to remove fruit that is lagging behind in ripeness will enhance uniformity of the crop. Removing wings on varieties like Pinot Noir and Cabernet Sauvignon will almost certainly improve overall ripeness.

Important: Follow up your crop estimates with accurate harvest estimates to confirm your accuracy. Because most grapes are sold by tonnage, either the grower or the wine maker or both should have legal tare weights which can be calculated for a field/block to determine final yields. Also, individual vines can be harvested and weighed to get an accurate estimate of harvest yield.

I always tried to achieve +/- 5%, and I have often been as close as 2% using the lag phase method but as far off as 50%. It's not a perfect system, no matter how accurate your sampling is. As you get closer to harvest, many variables may interfere with you accuracy. Dry weather will dehydrate

berries, rain will enlarge them, birds, deer, and disease will all affect crop levels. This is not an exact science, but each grower should attempt to reduce the variability as much as possible and try to be accurate. After many years of doing this, you will be able to stand back, look at your vines and say, “Looks like just a smidge over 3 tons per acre to me.” And, you might be right on the money.

Reference resources:

1. *Wine Grape Production Guide for Eastern North America*. Edited by Dr. Tony Wolf. 2008. Crop Yield Estimation and Crop Management. Tony Wolf. Chapter 7. Pages 135-140.
2. *Oregon Viticulture*. Edited by Dr. Ed Hellman. 2003. 2nd Edition. Crop Estimation and Thinning. Ed Hellman and Ted Casteel. Chapter 29. Pages 231-234.
3. *Predicting Yields in Oregon Vineyards* by Steve Price. Practical Winery and Vineyard. May/June 1988. Find a copy at the Pennsylvania Wine Grape Network website – <http://pawinegrape.com/>

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