Cornell University
College of Agriculture and Life Sciences

Estimating and Adjusting Crop Weight in Finger Lakes Vineyards

(Material handed out at a Finger Lakes grower twilight meeting – July, 2001)

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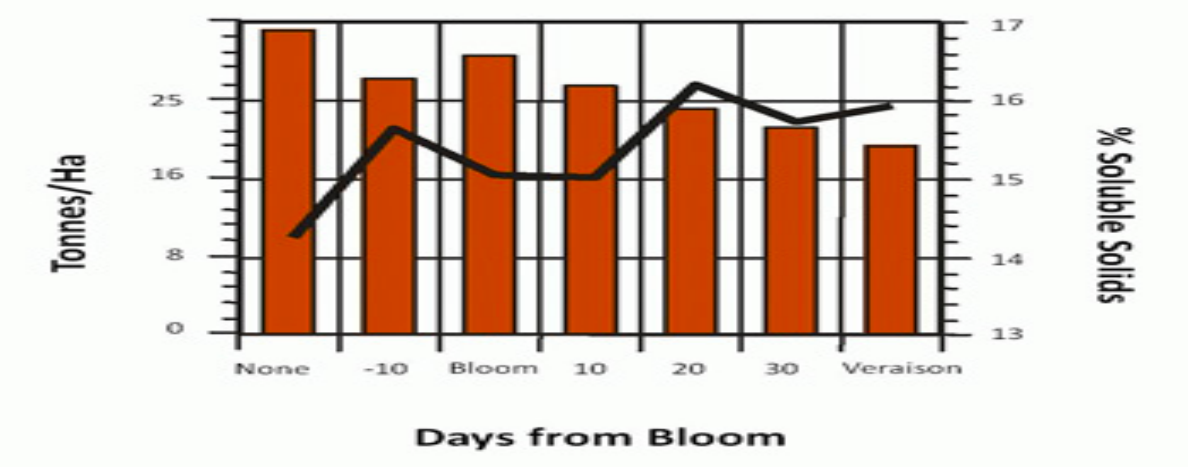
Why estimate your crop?

- Estimate crop size so you know how much money you can safely borrow.
- Estimate crop size so you can let your buyers know how much fruit to expect.
- Estimate crop size in order to ensure you will be able to meet your grape quality target.
- Estimate crop size to ensure vine size is maintained for future crops

What's the problem? – You are making a prediction, it's a guess

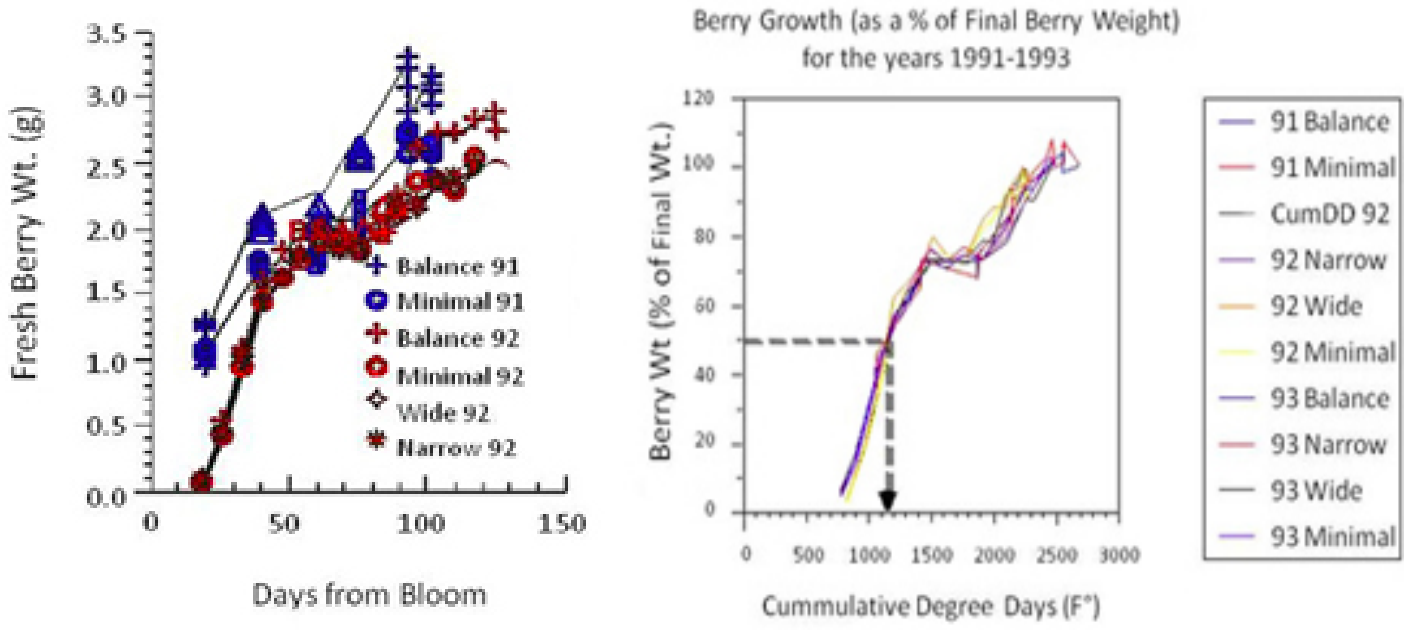
- Crops vary widely from year to year – winter injury, and the effect of previous and current season weather on fruitfulness, set and berry development all impact crop size.
- Prudent people tend to leave sufficient buds to ensure a satisfactory crop even in years when conditions are less than optimal. They have covered their rear for the bad years, but may suffer overcrops in "normal" years.
- Predicting crop size is done several times a year; you make a crop prediction when you decide how to prune a vine, sucker a vine and thin a vine BUT, the closer you are to harvest, the better the prediction is.



Effect of time of thinning to one cluster per shoot on yield (bars) and brix (line) of Concord grape vines (four year average).

The figure above shows that early thinning had a favorable impact on fruit composition, and maintained higher yield. Vine energy was not invested in fruit which was later removed. Adjusting crop 20 days after bloom (about 50% final berry weight) or later had a maximum impact on final fruit sugar. Delaying the adjustment beyond 20 days after bloom had a greater impact on yield than on composition.

The below figure on left shows the effect of different machine or hand pruning methods on seasonal growth of Concord berries (berry weight) over two seasons. Berry weight was greatly affected by crop size (pruning method) and weather (1991 had very favorable weather; in 1992 the weather was very unfavorable).



The same data is displayed on the right, but the data expressed as a fraction of the final berry weight of any individual year/pruning treatment combination. Note that most of the variability has disappeared. This kind of data can be used to predict future crop development.

Also note:

- For Concord – 50% of final berry weight was at about 1200 degree days. This is typically about 25 days after bloom.
- The 50% final weight does not coincide with the weight at “lag phase” (the time when berry weight changes little).
- Although the 50% final weight crop estimate was very accurate 9 out of 10 years, it failed in one year. In that year weather was very favorable for the first half of the season, but there was essentially no rain in the last half of the season. Late season berry development was hindered, the final berry weight was less than predicted, and as a result the crop was lighter than expected.
- This data is for Concord. It is reasonable to expect that varieties which bloom and mature at about the same time as Concord will have similar developmental curves. However, 1200 degree days may or may not be a good time to predict final crop size of other varieties.

Mid-season Cluster Counts vs. Cluster Wt. vs. Crop Wt. as a Predictor of Final Crop Size

In some places mid-season cluster per vine counts are used to predict harvest crop weight. Multiplying cluster number by expected final cluster weight produces a harvest fruit weight per vine value. The problem with this approach is consistency. When grapes are grown in regions where winter injury is not a problem; where the growing season provides plenty of heat and sunlight; and where the vines are irrigated, then year to year variation in components of yield (cluster number, berry number and berry size) will be low. Final cluster weight will vary among varieties but there will be little variation among years.

The Finger Lakes isn't like that, and a simple cluster count may not be as useful. However, by mid-summer many of the factors which cause variation have already occurred. Winter and spring freeze have done their damage. The impact of previous season's weather on cluster number and berry set has been expressed. If we know average cluster number and have a good estimate of current season average cluster weight you can make a pretty good estimate of harvest crop size.

The biggest problem is that word, average. Can you get an average cluster count? How do you take into account missing vines, big vines, small vines, etc.? That depends upon how much variation there is in the vineyard. Ideally there isn't much, and the variation is primarily related to site factors such as changes in slope or soil type rather than variation due to management. That kind of predictable variation can be accounted for. You can sample the vigorous and weak parts of your vineyard separately. However, if the variation is random, all you can do is sample more vines.

Can you get an average cluster weight? That also depends upon your vineyard. Average cluster weight in a machine pruned vineyard can be very difficult to obtain. Cluster weight is much less variable in an intensely managed VSP or Scott Henry trained vineyard. However, getting good cluster samples is hard in even the most highly managed vineyards. That is why in uniform vineyards picking the entire crop from a few sample vines reduces sampling error. However, destructive sampling is destructive, and I don't fault people who would prefer to use a non-destructive method. So if you keep a record of cluster number and cluster weight, you can get an idea of variation. Just remember that the estimate is only as good as the sample.

Variation in Cluster Weight Among Varieties

Quartiles for overall average vine cluster weight in lbs. at Geneva for the years 1997-2000.

Group	Number of Vines Measured	Lightest 25%	Mid-point	Heaviest 75%
Cabernet Franc	1034	0.25	0.29	0.32
Cabernet Sauvignon	1193	0.17	0.23	0.29
Chardonnay	3851	0.16	0.20	0.24
Pinot Noir	1137	0.17	0.21	0.24

The cluster weights reported in the above table represent whole vine averages and are reported as quartiles. For example for Cabernet Sauvignon 25% of the vines had an average cluster weight of 0.25 lbs. or less, 50% of the vines had an average cluster weight of 0.29 lbs. or less and 75% of the vines had an average cluster weight of 0.32 lbs. or less. This data covers vines which are the same variety, but which received very variable management. Differences include soil type, clone, rootstock and training system. I did not include data from vines with fewer than 15 clusters because they greatly added to the variability.

The columns marked, Average, in the next table refer to a whole vine average. Minimum average is the lowest per vine average cluster weight for vines with at least 15 clusters. Maximum average is the highest per vine average cluster weight for vines with at least 15 clusters. Varieties are ranked in order of increasing cluster weight (except PN clones which compare differences among clones).

Average cluster weight of individual vines at Geneva for the years 1997-2000.

	Number of Vines	Average Cluster Wt. (lbs.)	Minimum Vine Average (lbs.)	Maximum Vine Average (lbs.)
Chardonnay	3,832	0.20	0.01	0.57
Riesling	132	0.21	0.13	0.33
Cabernet Sauvignon	1,193	0.24	0.03	0.81
Gamay Noir	165	0.25	0.05	0.45
Dornfelder	160	0.25	0.02	0.60
Shiraz	154	0.27	0.09	0.56
Merlot	96	0.28	0.14	0.43
Cabernet Franc	1,034	0.29	0.11	0.75
Limberger	13	0.32	0.25	0.37
Pinot Noir Clones				
Meunier	15	0.15	0.11	0.19
Canada	13	0.16	0.08	0.24

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Average cluster weight of individual vines at Geneva for the years 1997-2000 (Cont.)				
	Number of Vines	**Average Cluster Wt. (lbs.)**	**Minimum Vine Average (lbs.)**	**Maximum Vine Average (lbs.)**
Pernand	15	0.17	0.12	0.21
Espiq	11	0.17	0.14	0.20
115	140	0.17	0.03	0.29
Calera	98	0.19	0.08	0.31
113	121	0.20	0.02	0.37
Geneva	69	0.20	0.07	0.32
Gamay B.	16	0.20	0.15	0.26
Spateburg	12	0.21	0.14	0.29
Pomard	13	0.21	0.06	0.29
164	164	0.21	0.10	0.32
Mariafeld	221	0.22	0.11	0.43
Cl 29	179	0.24	0.17	0.30
10/18	179	0.25	0.08	0.53
Average for all PN Clones		0.20		

This table is meant to give you a handle on average cluster weight for different varieties, but also to reinforce the warning about variation in your vineyard. For Chardonnay, the overall average cluster weight is 20 times heavier than that of the vines having the lightest average cluster weight. Cluster weight on vines with the highest average cluster weight was 3 times heavier than the weight on average vines. Remember these are whole vine averages. I'm sure you recognize that the within vine variation is at least as large as the between vine variation.

Using a Mid-season Weight Estimate

Your estimate may be the result of single or multiple vine harvests or cluster sampling to get an estimate of mid-season cluster weight which will be used along with vine cluster counts to get a final harvest estimate. In the table below, look at your vine spacing. Double the estimated half season weight/vine to get an estimate of harvest weight. Then divide your estimated harvest weight by the factor in column 4 to estimate final crop size. You can also use this method to decide how much fruit to remove. Let's assume you have an estimated crop of 5 tons/acre but you only want 4. You need to remove 1 ton/acre of potential fruit. Assuming a 9′ x 6′ spacing you would need to remove 1.25 lbs./vine (1/2 of the final 2.5 lbs./vine) or (2.5 lbs./ 0.22 lb./cluster = 11 clusters/vine).

Effect of cluster number or weight per vine on yield of vines at different vine and row spacing.							
Row Space	Vine Space	Vine/Acre	lbs. Fruit/Vine to make a Ton/Acre	Clusters/Vine to make a Ton/Acre at different harvest cluster wt. (lb.)			
				0.15 lb. Cluster	0.20 lb. Cluster	0.22 lb. Cluster	0.25 lb. Cluster
6	4	1,815	1.1	7.3	5.5	5.0	4.4
9	6	807	2.5	16.5	12.4	11.3	9.9
9	8	605	3.3	22.0	16.5	15.0	13.2

Using cluster counts requires you to estimate final cluster weight, either from experience or from vine sampling. Let's play with some numbers. For vinifera we believe it takes 3 to 4 shoots/foot of VSP trellis to achieve trellis leaf fill. Let's assume you have Chardonnay spaced at 9′ x 6′ feet and you adjust shoot number to one per bud before bloom. The data below illustrate effect of pruning level (3, 4 or 5 buds/foot of row), cluster thinning, and average harvest cluster weight on yield/acre.

Effect of shoot/foot of row, clusters per shoot and harvest cluster weight on yiled/acre (tons).					
Shoots/foot of row	Buds/Vine	Clusters/shoot	Average Harvest Cluster Wt. (lb.)		
			0.10	0.22	0.30
3	18	1	0.7	1.6	2.2
		1.5	1.1	2.4	3.3
		2	1.5	3.2	4.4
4	24	1	1..0	2.1	2.9
		1.5	1.5	3.2	4.4
		2	1.9	4.3	5.8
5	30	1	1.2	2.7	3.6
		1.5	1.8	4.0	5.4
		2	2.4	5.3	7.3

Does it Work?

Let's look at some year 2000 Pinot noir data from a thinning experiment we are doing at Geneva.

		Thinned Fruit Amount		Harvest				
	Thinning Date	**Clusters/ Vine**	**lbs./ Vine**	**Clusters/ Vine**	**Clusters/ Wt. (lb.)**	**Tons/ Acre**	**Berry Wt. (g)**	**Brix**
Not Thinned	None	0.0 c	0.0 d	47.1 a	0.22 b	4.1 a	1.42 a	21.2 a
1.5/clu/shoot early	July 2	4.5 b	0.2 d	38.5 b	0.21 b	3.3 b	1.41 a	21.6 a
1/clu/shoot early	July 2	17.7 a	0.6 c	26.6 c	0.22 b	2.4 cd	1.46 a	21.3 a
1/clu/shoot late	Aug. 3	17.9 a	3.1 a	25.1 c	0.22 b	2.2 d	1.49 a	21.2 a
selective-late	Aug. 3	17.1 a	2.4 b	27.1 c	0.25 a	2.7 c	1.47 a	21.5 a

Vines are at 9′ x 6′ and are shoot adjusted to a goal of 24/vine. The data show that unthinned vines had just under 2 clusters/shoot and average cluster weight was 0.22 lbs. except where we did selective thinning. Our harvest crop fits well with the predictions used by the table above. We had 4 shoots/foot of row. At 2 clusters/shoot we predict 4.3 tons. In fact we had 1.9 clusters/shoot and 4.1 tons. At 1.5 clusters/shoot the predicted yield was 3.2 tons and in real life we got 3.3. At 1 cluster/shoot the prediction was 2.1 tons and we actually got 2.4.

With selective thinning our goal was to remove poorly developing (less ripe) clusters at veraison. The selective thinning worked, but selectively removing small clusters increased the average weight of retained clusters to 0.25. This increase affected our ability to predict final crop. This is important because you will probably not ask your workers to randomly remove fruit when they thin. If they selectively remove small clusters or any 3rd clusters growing on a shoot, you will tend to increase the average weight of those clusters your remove. For large clustered varieties this could be very significant.

Summary

The more you know about your vineyard the better off you are. This is especially true about crop estimates. I'm told that National Grape Coop fieldmen in Washington State whose crop estimates are more than 5% off don't get a year-end bonus. That's motivation, but the processors need to know how much fruit is available so they know how low they set the August 15 stated price.

You want to know your crop size to make sure you have a home for all your fruit and that you don't make promises you can't keep. If you are tied into a quality market, you may also need to know so that you are able to meet the expectations of the buyer. Buyers that pay a premium for quality want quality delivered.

Finally, a good crop estimation system allows growers to hedge their bets. I'm in favor of waiting as long as possible to make the FINAL crop adjustment. Lighter pruning and shoot thinning, within reason, is just good insurance, but failure to adjust a deliberate **potential** overcrop, meant as insurance before it becomes an **actual** overcrop, is bad for long term grower/producer relations. As an industry we will need to produce better (more valuable) grapes if our winemakers are to produce better (more expensive) wines.