Michigan Grape and Wine Industry Council
Research and Education Advisory Committee

Final Report on Research Activity

Crop Estimation and Sampling to Achieve Optimal Fruit Maturity and Quality Under Michigan Condition

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Objectives: The Michigan wine industry is faced with the challenges of high frost and winter injury risk, a relatively short growing season, and inconsistent heat accumulation. There is a great deal of variation from one season to the next, and vines can undergo a "see-saw" effect from being under-cropped (due to frost, poor set or winter damage) and over-cropped the following season (due to inherent potential for rebound after a poor year, as well as financial pressure on growers to make up for previous years losses). Under these conditions it is essential to keep a long-term focus on vine balance – that is, to obtain maximum fruit maturity in the current season without stealing from the following year's crop. In order to achieve such balance, growers must be able to sufficiently predict yield potential. The protocol provided to them must be accurate and easy to use in order for them to remain motivated each year to carry it out.

It was originally planned that proposed work would involve testing the applicability and accuracy of existing sampling and crop estimation protocols:

1. Estimation using long-term average berry weights.
2. Concord Crop Adjustment (Bob Poole and Terry Bates, Corning, NY). The prediction of final yield based on the premise that Concord grapes are approximately half their final weight at 1200 GDD (Growing degree days). The use of cumulative heat units as an indicator of the halfway point in berry weight needs to be tested on a range of varieties grown in Michigan.

However, due to financial constraints we have chosen to focus only on the first two methods listed above.

2003/2004 Experiment

The use of long-term average berry weight is being assessed over a 6-year period using varietal data from a number of vineyard locations. Crop estimation calculations using this parameter will then be compared to actual yield data.
The use of GDD as a marker for 50% berry weight has been shown effective in Concord, and is estimated to occur at 1200 GDD. Our work aimed to provide the GDD points at which specific varieties reach approximately half of their final weight.

On each of these varieties 60 berries were randomly selected, tagged, and diameter measurements taken at weekly intervals using digital calipers. During each measurement period, a 30-berry random sample was collected from each cultivar, and a linear regression of berry weight x berry diameter was developed. We created graphs of berry diameter (weight correlation) and GDD to determine GDD stage where berries are at half of final weight.

Figure 1. An example of how clusters and berries were tagged for caliper measurements.

Appendix 2003:

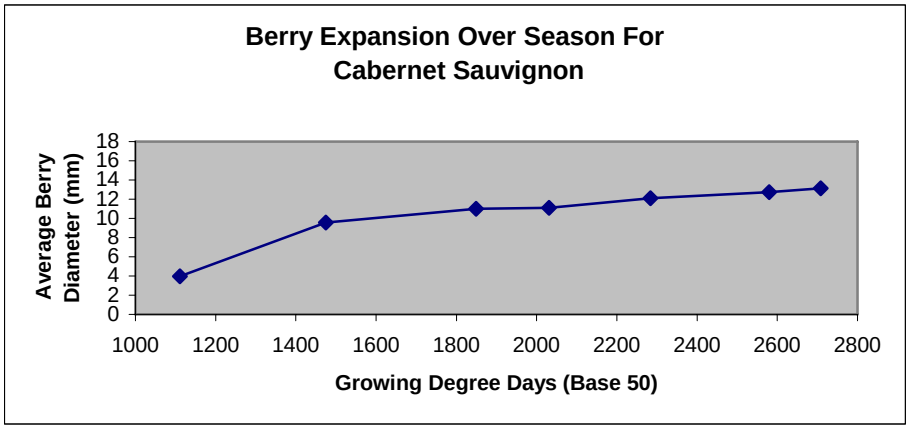


Figure 2: Berry expansion over season for Cabernet Sauvignon, reached half of it's final fresh weight on **14 July 2003 at 1207 GGD**.

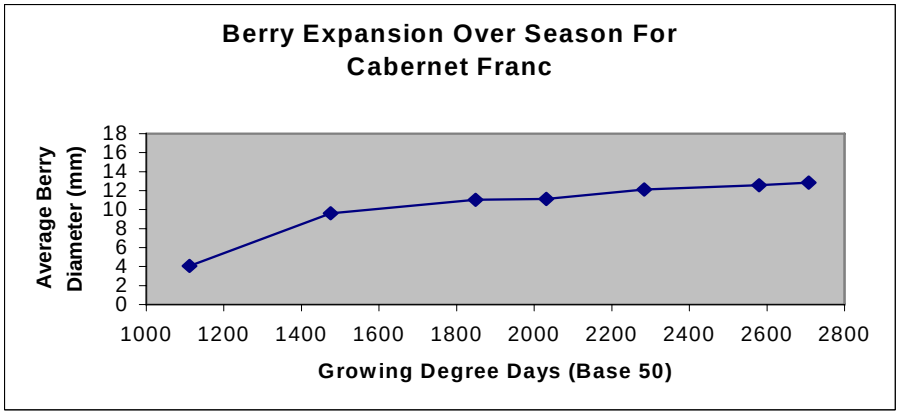


Figure 3: Berry expansion over season for Cabernet Franc, reached half of it's final fresh weight on **12 July 2003 at 1168 GGD**.

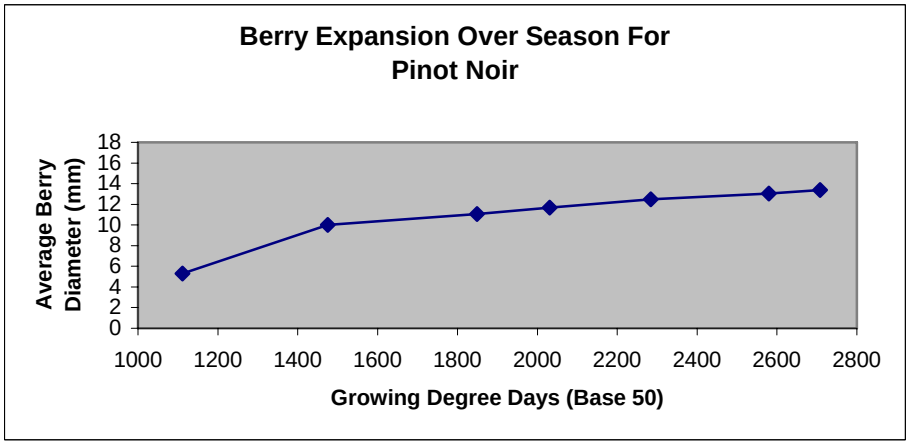


Figure 4: Berry expansion over season for Pinot Noir, reached half of it's final fresh weight on **10 July 2003 at 1137 GGD**.

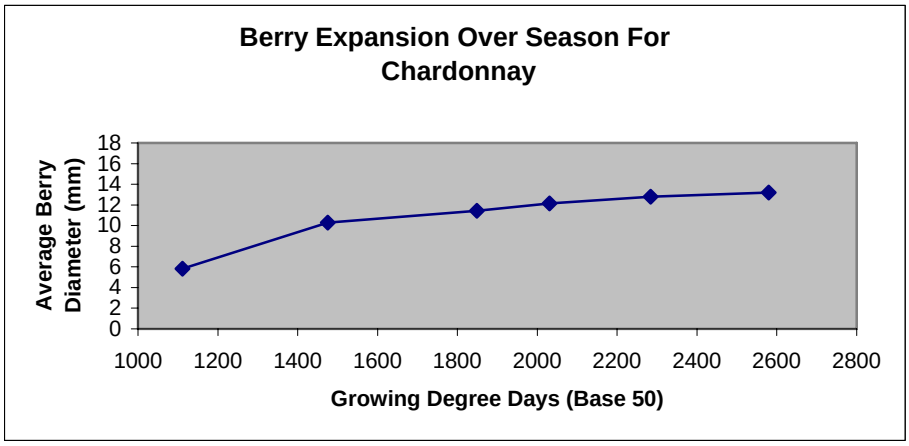


Figure 5: Berry expansion over season for Chardonnay, reached half of it's final fresh weight on **7 July 2003 at 1070 GGD**.

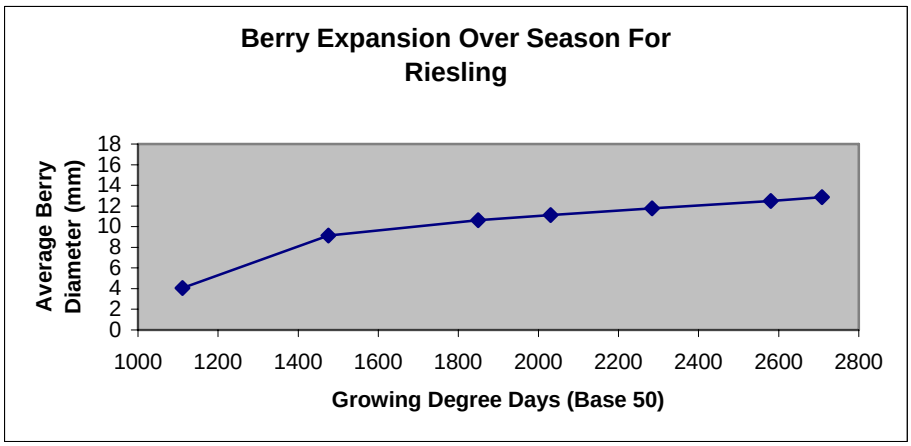


Figure 6: Berry expansion over season for Riesling, reached half of it's final fresh weight on **13 July 2003 at 1185 GGD**.

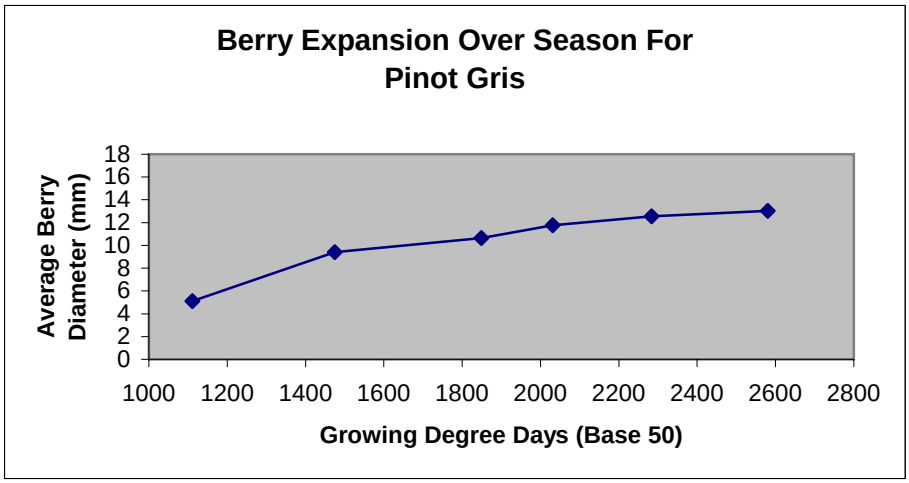


Figure 7: Berry expansion over season for Pinot Gris, reached half of it's final fresh weight on **11 July 2003 at 1153 GGD**.

Appendix 2004:

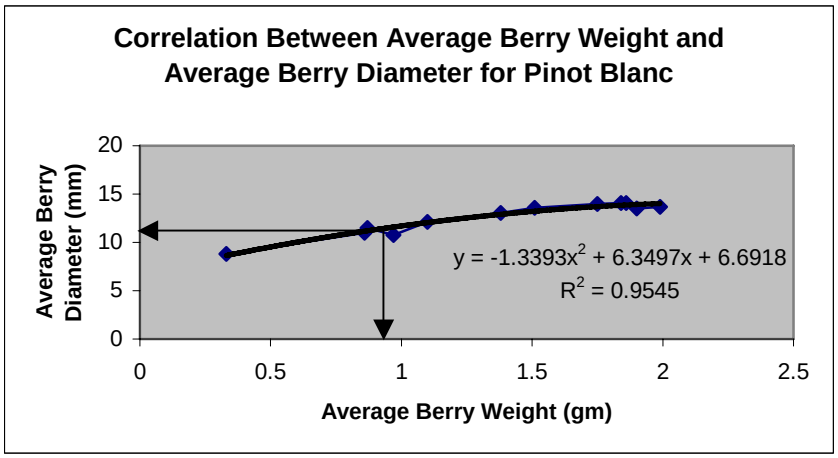


Figure 8: Correlation between average berry weight and average berry diameter for Pinot Blanc. Reached half of its final fresh weight on **22 July 2004 at 1469 GGD** (see arrows).

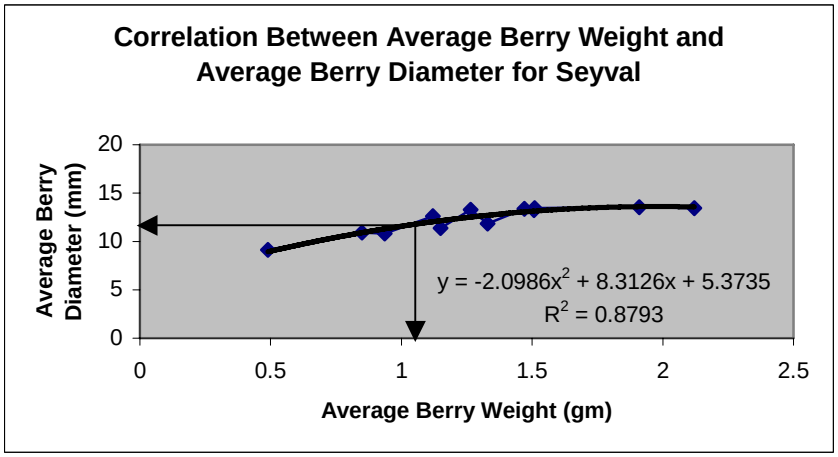


Figure 9: Correlation between average berry weight and average berry diameter for Seyval. Reached half of its final fresh weight on **4 August 2004 at 1703 GGD** (see arrows).

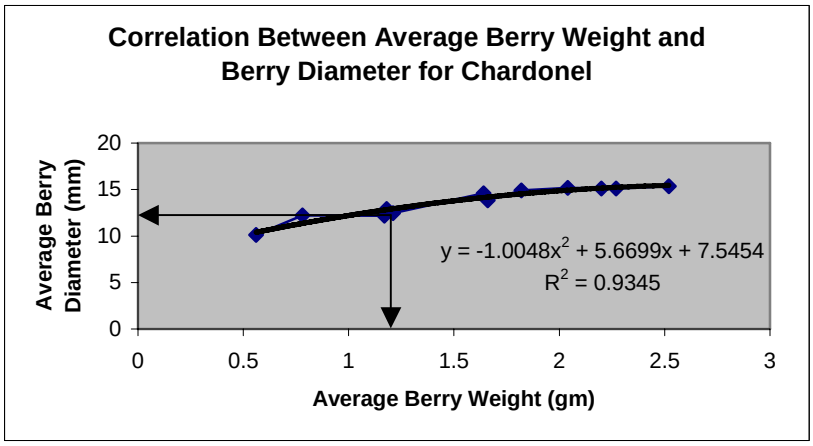


Figure 10: Correlation between average berry weight and average berry diameter for Chardonel. Reached half of its final fresh weight on **12 August 2004 at 1813 GGD** (see arrows).

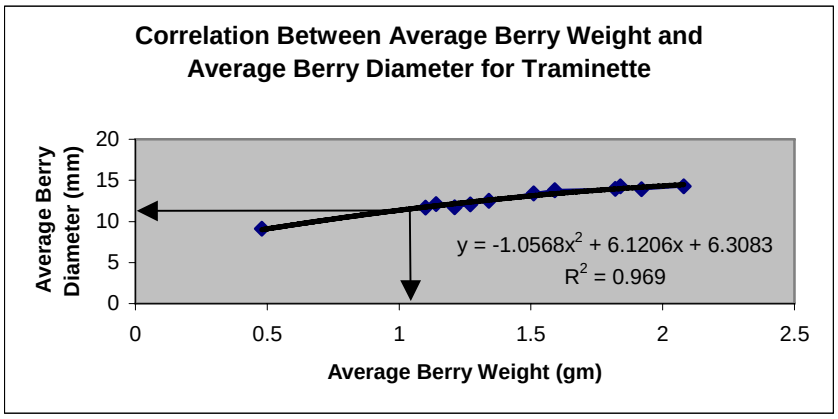


Figure 11: Correlation between average berry weight and average berry diameter for Traminette. Reached half of its final fresh weight on **22 July 2004 at 1469 GGD** (see arrows).

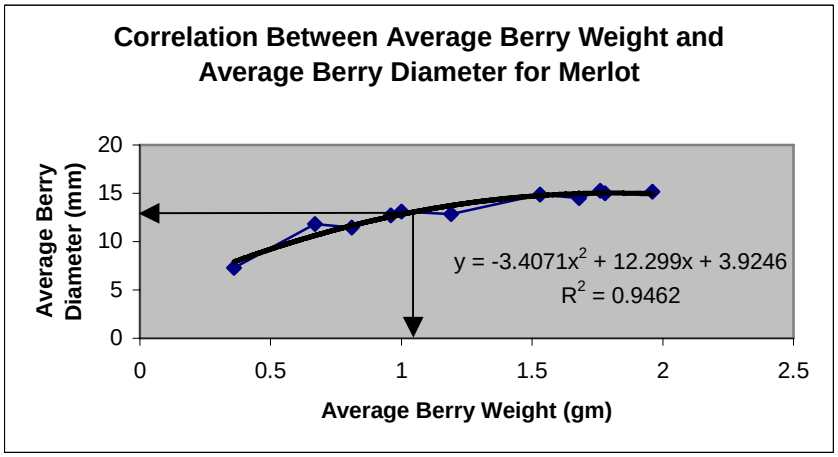


Figure 12: Correlation between average berry weight and average berry diameter for Merlot. Reached half of its final fresh weight on **4 August 2004 at 1703 GGD** (see arrows).

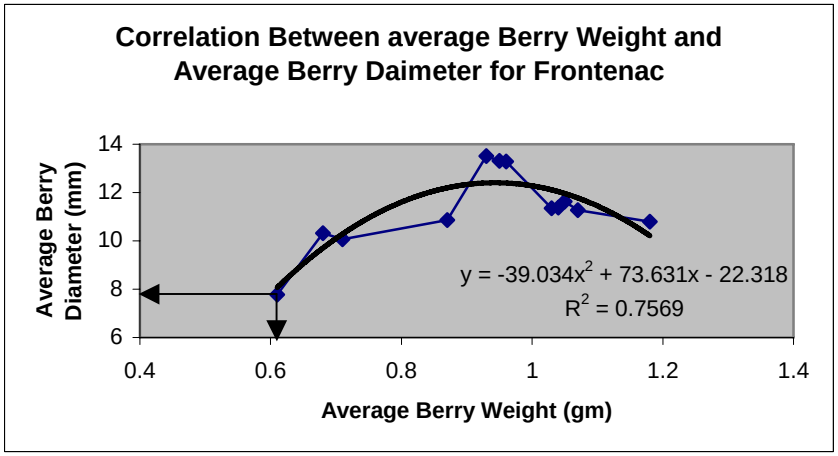


Figure 13: Correlation between average berry weight and average berry diameter for Frontenac. Reached half of its final fresh weight on **13 July 2004 at 1183 GGD** (see arrows).

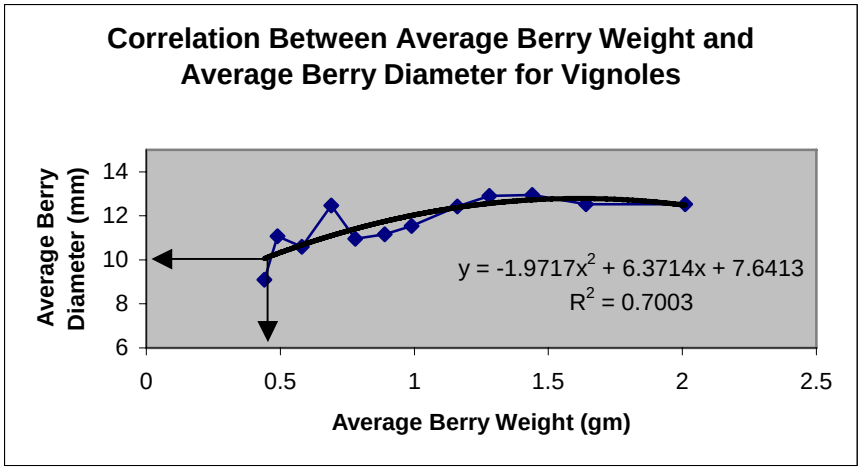


Figure 14: Correlation between average berry weight and average berry diameter for Vignoles. Reached half of its final fresh weight on **18 August 2004 at 1748 GGD** (see arrows).

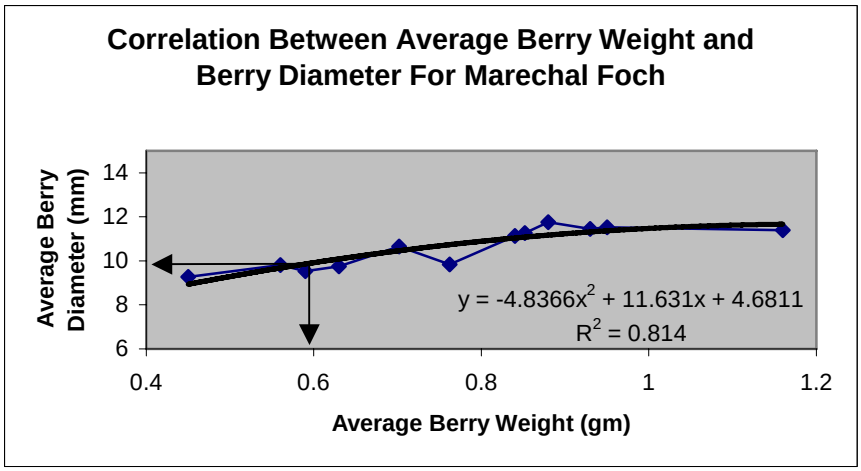


Figure 15: Correlation between average berry weight and average berry diameter for Marechal Foch. Reached half of its final fresh weight on **21 July 2004 at 1333 GGD** (see arrows).

The berry diameter and GGD correlation graphs for each of these varieties assessed in 2004 would be available on request.

Results of 2005.

It was critical that all the results of the proposed estimation be tested by harvesting 3-vines for each cultivar (10 CV's total), at the determined GDD point. With the collected data at mid-point, we made a crop estimation calculation, which was ultimately compared with actual final yield.

Appendix 2005 contains the data collected in 2005 regarding relationship of berry weight to diameter since diameter could be measured non-destructively on the same berry. Table 1 contains the data collected regarding the GDD at ½ final berry weight and the actual final yield. The data are characterized by two things: 1) the late season (in terms of GDD for ½ final berry weight for Pinot blanc and Merlot (1469 and 1703, respectively) and 2) the very poor, over estimation for Marechal Foch and Riesling. Over

estimation of yield for the latter two is not surprising given the unique growing season of 2005, with the season long dryness, especially during the 3-7 weeks prior to harvest (depending on the cultivar), lack for water for fruit sizing was logically a factor.

What is remarkable to us, given the season, was the accuracy of the predicted yields. Of the 10 cultivars evaluated, three were off by less than ½ ton/acre, and eight were off by 1.6 T/A or less. We would like to see accuracy of prediction in the 0.75 T/A range and believe that this is possible with expansion of the number of estimator vines harvested at ½ final berry weight from three to six. However, it must be understood that grapevines are biological organisms subject to the vagaries of climate and weather and estimates are always to be considered as tools for judgments, not gospel truth. Hopefully with refinement, the predictions can gain the robustness to overcome the variations of vine culture in a highly variable climate.

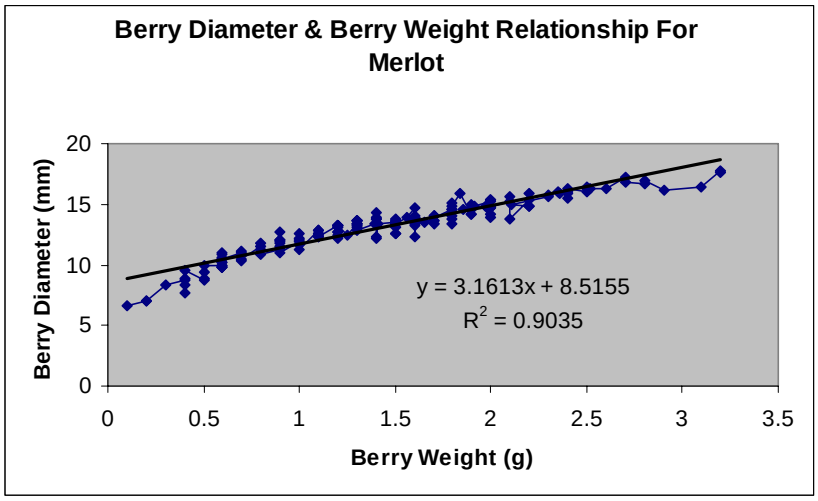
This effort needs further refinement and it is hoped that whomever becomes the viticulturist will work closely with MGWIC and industry leaders to refine these current suggestions.

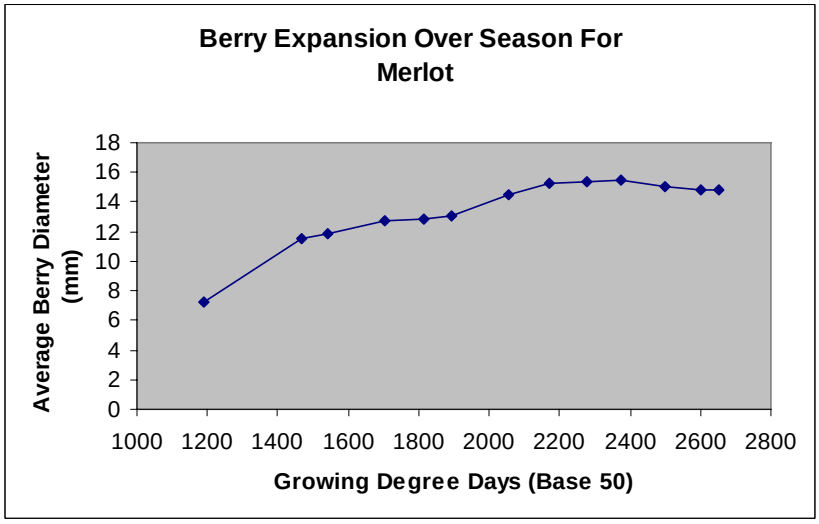
Table 1. Growing Degree Day (base 50°F), Projected Final Yield (T/A) and Actual Final Yield Data for Ten Wine Grape Cultivars.

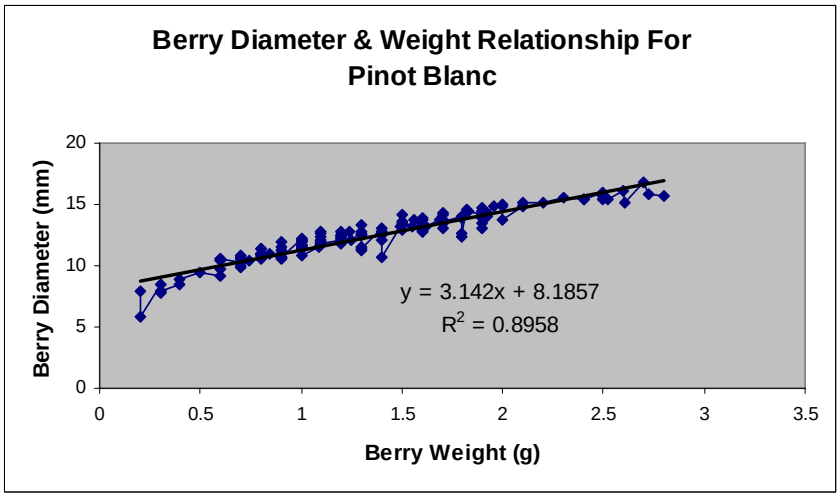
Cultivar	GDD @ 50% Final Berry Wt.	Estimated Final Yield (T/A)	Actual Field Yield (T/A)	Variance from Estimate (T/A)
Cabernet Franc*	1168	4.57	5.79	1.22
Cabernet Sauvignon*	1207	7.60	7.83	0.23
Frontenac#	1182	3.03	4.62	1.59
Marechal Foch#	1182	10.69	3.04	7.65
Merlot*	1703	4.98	3.58	1.40
Pinot blanc*	1469	5.45	5.43	0.02
Pinot gris*	1153	5.85	6.30	0.45
Pinot noir*	1137	2.89	3.63	0.74
Riesling*	1185	12.37	4.09	8.28
Vignoles#	1182	5.25	6.11	0.86

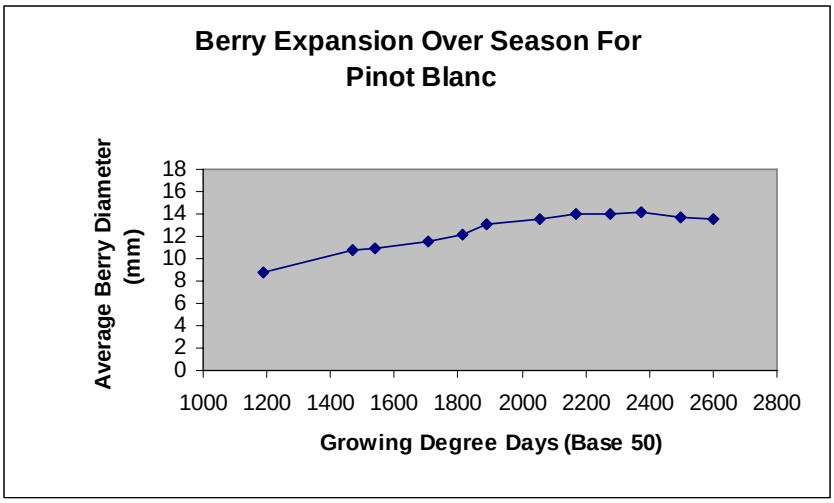
* SWMREC
#HTRC

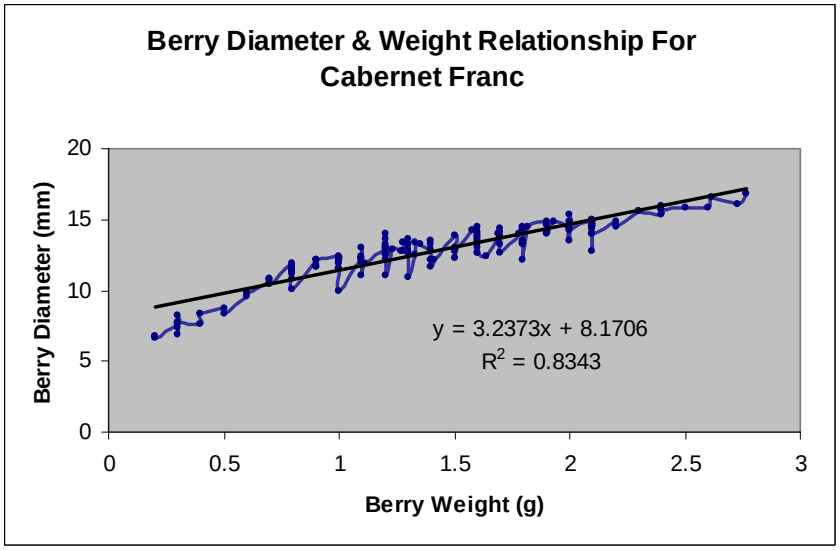
Appendix 2005:

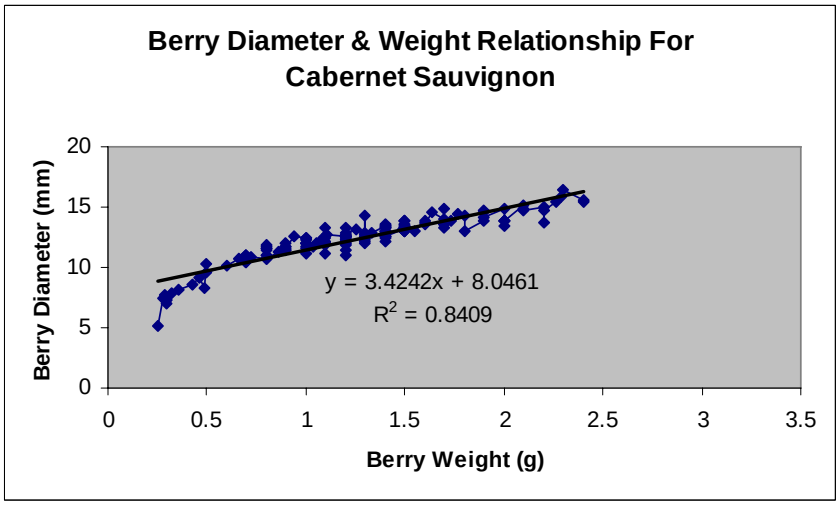


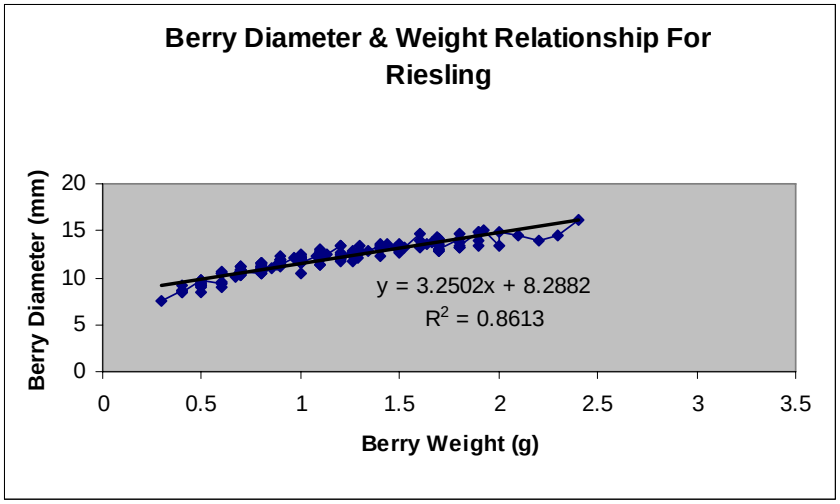


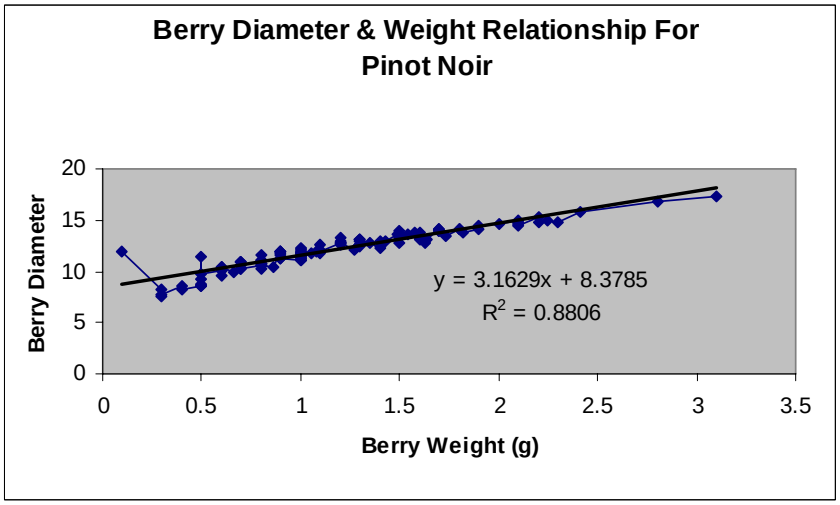


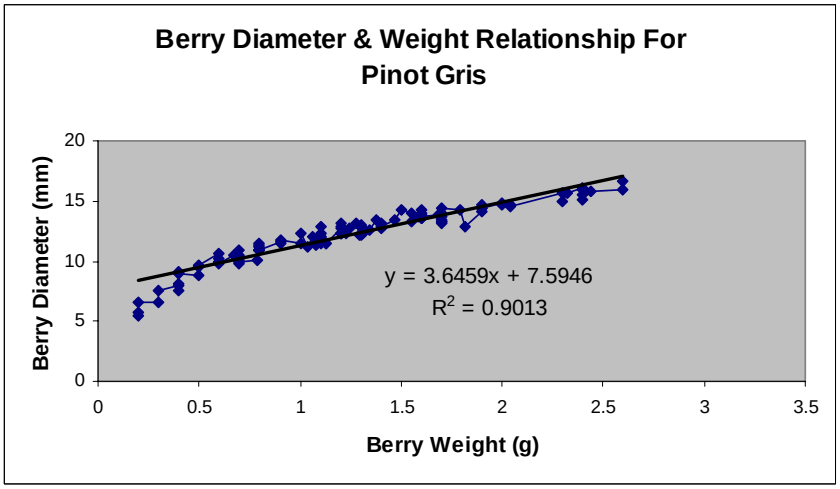

Berry Expansion Over Season For Pinot Blanc
Average Berry Diameter (mm)
18
16
14
12
10
8
6
4
2
0
1000 1200 1400 1600 1800 2000 2200 2400 2600 2800
Growing Degree Days (Base 50)


Berry Diameter & Weight Relationship For Cabernet Franc
Berry Diameter (mm)
20
15
10
5
0
y = 3.2373x + 8.1706
R2 = 0.8343
0 0.5 1 1.5 2 2.5 3
Berry Weight (g)


Berry Diameter & Weight Relationship For Cabernet Sauvignon
Berry Diameter (mm)
20
15
10
5
0
y = 3.4242x + 8.0461
R2 = 0.8409
0 0.5 1 1.5 2 2.5 3 3.5
Berry Weight (g)


Berry Diameter & Weight Relationship For Riesling
Berry Diameter (mm)
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
Berry Weight (g)
y = 3.2502x + 8.2882
R2 = 0.8613


Berry Diameter & Weight Relationship For Pinot Noir
Berry Diameter
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
Berry Weight (g)
y = 3.1629x + 8.3785
R2 = 0.8806


Berry Diameter & Weight Relationship For Pinot Gris
Berry Diameter (mm)
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
Berry Weight (g)
y = 3.6459x + 7.5946
R2 = 0.9013