The Lake Erie Regional Grape Program

PENNSTATE

Bud Break- courtesy of Golnaz Badr- PhD, CLEREL

Lake Erie Regional Grape Program

Vineyard Notes-May 22, 2018

Cornell University
Cooperative Extension

Building Strong and Vibrant New York Communities

Business Management

Kevin Martin, Penn State University, LERGP, Business Management Educator

Cost of Production: Current Costs and Forecasts

After nearly two decades of low interest rates it is possible that credit may not be historically cheap forever. Sustained economic growth is an elusive target. Recent periods of steady growth have ended in recessions before interest rates get a chance to rise significantly. This is not likely a concern for all growers. Many older growers have a great deal of equity built into their operation and debt service is not a particularly important cost. This period of low prices, however, has decreased the number of debt free vineyards. Tapping equity has been one way to weather the storm. If interest rates continue to rise the cost per acre on variable rate loans will quickly become unsustainable.

There are a number of indicators that allow the prediction of higher interest rates. The Federal reserve, through monetary policy (money supply), influence interest rates and inflation. Their stated policy goals include full employment and 2% inflation. Full employment has been realized just recently. Inflation is lagging behind but is approaching 2%. The Federal Reserve will now raise target rates to 3% by the end of 2020.

It is likely that borrowing costs will rise around 2% or more. Access to credit is complicated and the Reserve doesn't actually have the power to change mortgage rates, just a tool that has the ability to influence mortgage rates and other important forms of credit.

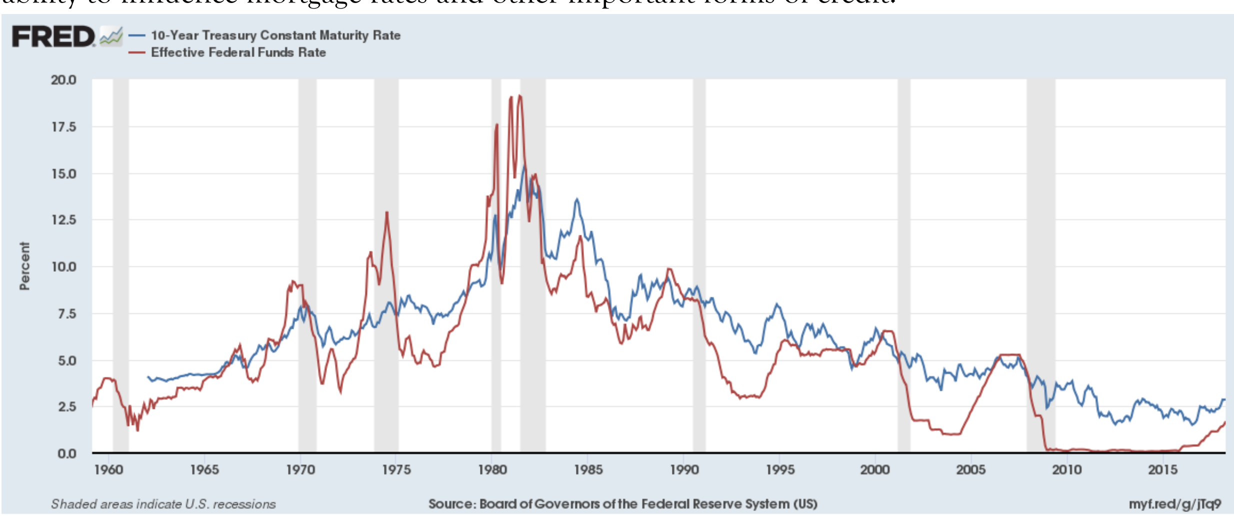

Figure 1: Effective Federal Funds Rate (red) begins to rise but remains historically low. 10 Year T notes rose earlier in the decade.

The ten-year treasury note is driven, in part, by market demand. These rates rise based not one what the reserve wants but what the market thinks will happen with interest rates and inflation in the future. The market has been reluctant to bet against the US economy and resistant to interest rates below 2.5%. Despite a funds rate near 0%, treasury yields were closer to 2%. Treasury yields have followed the funds rate upward trajectory. Market watchers considered 3% an important ceiling that was briefly exceeded in May.

This has translated to higher borrowing costs already; most forms of credit are nearly 1% higher than a year ago. For a grape grower with a crop loan of $700 per acre, the grower will see interest expenses increase by a modest $5 per acre. For a grape grower that has an average amount of equipment and uses variable rate financing to regularly replace (10 – 15 years) tractors and harvesters, interest costs will rise by $20 - $30 per acre. A grower expanding his operation could see interest expenses increase on land mortgages by $40 per acre.

Those increases describe what may have already happened based on macroeconomic trends. The market expects those costs to continue to rise. A reasonable business plan would increase interests' costs by another $10 for a crop loan, $50 for equipment loans and $80 for fixed rate land mortgages. I would expect vineyard values to decrease by $300 per acre, which would reduce the additional interest costs on land mortgages.

As previously mentioned, the Reserve has been close to its stated goal of 2% inflation. This will raise costs for growers in a number of ways. See figure 2 for a historical perspective of PCE inflation. Inflation has been low for years and not problematically high in the last 30 years. Given current trends, costs will not rise universally. Cost increases will probably be focused on labor expenses. This type of inflation will lead to cost increases of $20 – $35 per year. Individual changes in specific markets, not inflationary trends, will probably continue to have larger impacts on short term expenses.

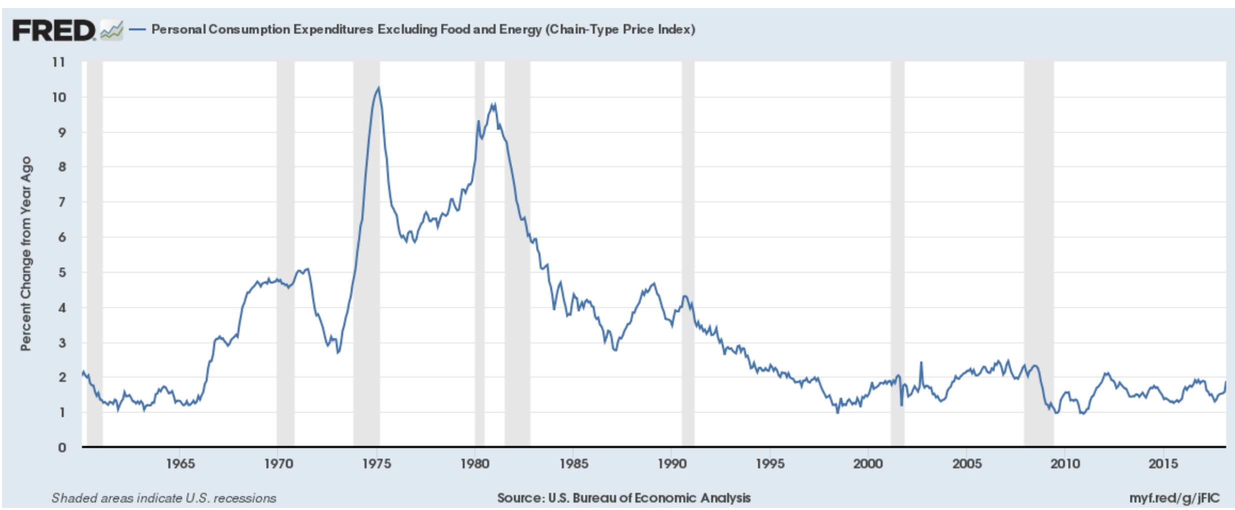

Figure 2: Long term Personal Consumption Expenditures (Core) trends show costs rising significantly less in recent years.

A grower with no debt may be able to effectively manage a vineyard for one year for $650 per acre. One should plan on those costs increasing by $50 - $100 per acre in the medium term. A grower needs an additional $900 dollars per acre to maintain investments in capital and equipment and income for unpaid labor. One should plan on those costs increasing by $50 per acre. Total debt service and/or ROI has the potential to significantly drive up vineyard operational costs more than other factors. Costs for vineyards carrying a significant amount of variable rate debt could increase from $2,100 to $2,300 per acre.

	Labor Cost	Equipment Cost	Material Cost	**Total Cost**
Total	**493.58**	**436.16**	**615.93**	**2,160.67**
Pruning and Brush Pulling	237.76			**237.76**
Tying & Renewal	$101			**101.01**
Brush Chopping (2x)	11.20	20		**31.20**
Fertilizer (3x)	5.60	8.75	211.325	**225.68**
Trellis	32.00	28	90.6	**150.60**
Weed Control (3x)	19.60	41.25	120	**180.85**
Mowing (2x)	22.40	20		**42.40**
Fungicide, Pesticide (5x)	21.40	95.12	194	**310.52**
Harvest	30.09	150.00		**180.09**
Trucking	12.52	73.04		**85.57**
Crop Insurance				**90.00**
Debt/Return On Investment		4.5%		**525.00**

Figure 3: Grape Production costs broken down by activity and source highlight labor costs and interest as key expenditures that vary from farm to farm.

One last note is that these cost increases have been on the horizon for 15 years. The economy is more mature (which is a nice way of saying the US population is old and technology is not rapidly developing). The sluggish economic growth has not provided an opportunity to justify higher cost borrowing. It's possible that an economic slowdown would prevent these costs from rising.

Viticulture

Jacqueline Dresser, Viticulture Extension Support Specialist, LERGP

Shoot Thinning for the Future: Applying Variable Rate Technology

Introduction

Dormant season pruning is the first chance to set yield potential for the coming year, which may be adjusted by thinning shoots, thinning fruit, or a combination of the two during the following growing season. While pruning is a consistent practice in all viticultural regions, adoption of shoot thinning and/or fruit thinning is far from ubiquitous. The objective of this article is to make the case for the first practice, shoot thinning, as an addition to a sound vineyard management plan that builds vine size over time and improves the consistency of ripening in both long and abbreviated growing seasons. We will also discuss how variable rate technology can be integrated to achieve perennial production goals by identifying and compensating for spatial variation in the vineyard.

Let's talk about Crop Load

Successful shoot thinning decisions hinge upon an understanding of crop load. The concept of crop load is something that every grower, perhaps unconsciously, considers at pruning time when deciding how many buds to retain. The act of pruning is directly manipulating crop load for the following season. The accumulated prunings that fall to the vineyard floor from a vine represent its 'size' in the previous season and its capacity to ripen a given yield in the next season. By calculating the ratio between a vine's pruning weight (vine size) and the amount of fruit that was picked from it at harvest (yield), a vine's crop load can be considered numerically. This ratio, termed Ravaz Index, was developed as a retrospective assessment of crop load post-harvest (Ravaz 1911). There are several other metrics of crop load that provide the flexibility of in-season manipulation. The growth yield relationship uses pruning weight in year one as a predictor of a vine's capacity to ripen a given yield in year 2 (Partridge 1925). Crop load may also be considered using the leaf area to fruit weight ratio, though leaf area measurements require at least some leaves to be stripped in season and run through a leaf area meter (Kliewer and Dokoozlian 2005). To summarize:

- Ravaz Index = Yield (lbs/vine) / Pruning weight (lbs/vine) (grown in same year, retrospective)
- Growth Yield Relationship = yield (lbs/vine, year 2) / pruning weight (year 1)
- Leaf Area to Fruit Weight ratio = yield (g) / leaf area (cm^2) (grown in same year)

Given the metrics for crop load, the next logical question is how to determine if vines are overcropped, undercropped or balanced. Here, the literature lacks a specific solution, as the ideal crop load varies by climate, cultivar, management and production goals. The ranges claimed to be ideal for ravaz index are between five and ten and 1.1 to 1.4 kg/m^2 for leaf area to fruit weight ratio (Bravdo et al. 1985, Naor et al. 2002, Kliewer and Dokoozlian 2005). Lacking a model tailored to Concord production in the Lake Erie region, Dr. Terry Bates mined through decades of data from various thinning experiments from the Fredonia Lab archives and determined that in a typical season, a ravaz index of 10 to 14 is balanced (Figure 1). A one-pound Concord vine is able to ripen just three to five tons of fruit per acre without seeing a decrease in vine size and yield potential in the next season, while a three pound vine is able to handle 9 – 12.5 tons per acre (Figure 1). I can just hear Nelson Shaulis' voice ringing in all of your ears, "Grow a vine first!" To be clear, *growing* a vine is a water and nutrient management issue (which is not the subject of this article), while *maintaining* a vine is a crop load management issue. The two must be optimized in tandem to sustainably increase yield potential over time.

Balancing crop load means that crop size is well matched to vine size. This will maximize fruit quality, keep vine size stable, and optimize canopy efficiency and carbohydrate production and storage. If small vines are left to bear a large crop, they are overcropped. The consequences of overcropping are diminished fruit quality, poor

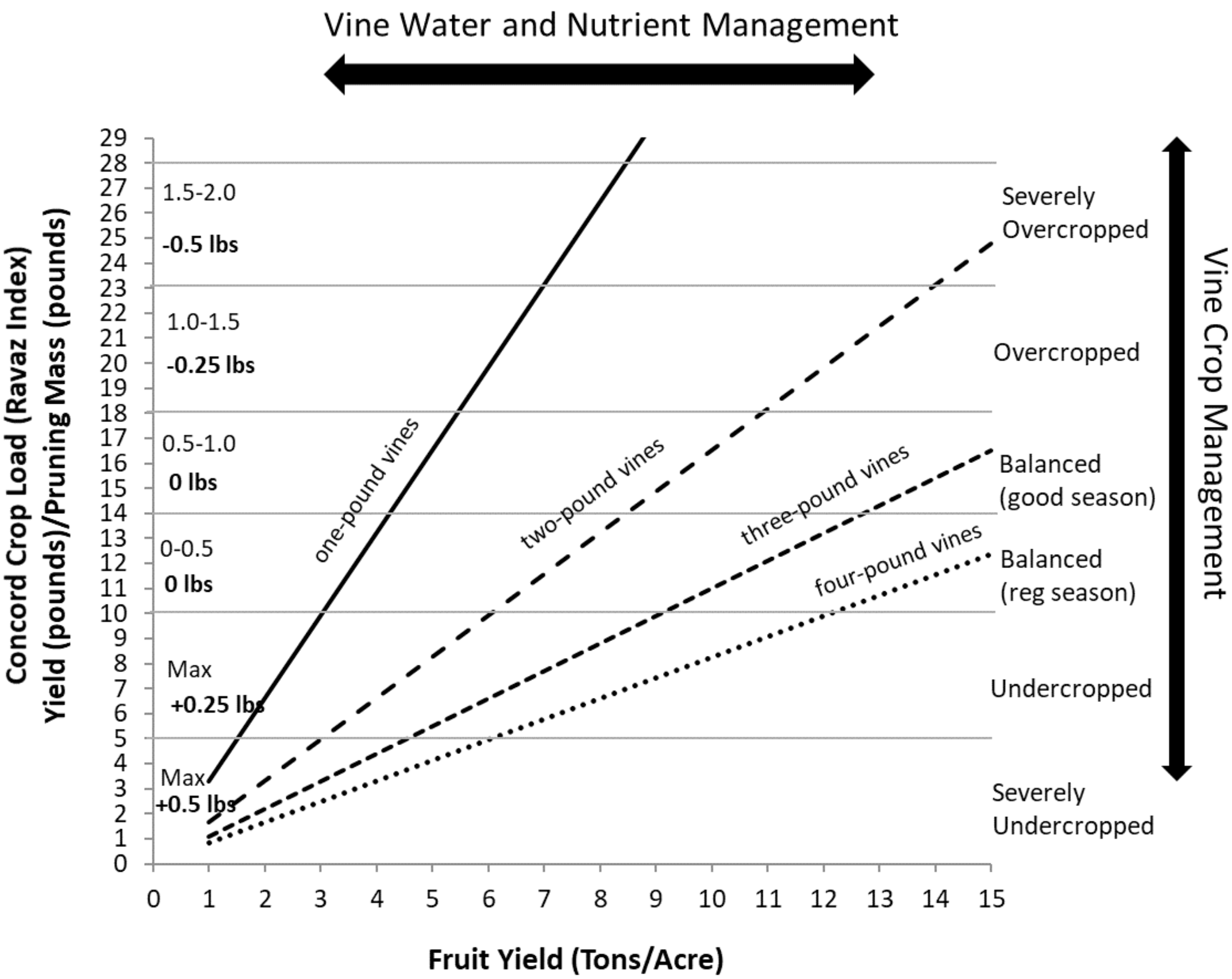

Figure 1. Crop Load Model for Lake Erie Concord. Courtesy of Dr. Terry Bates.

shoot growth and wood production and maturity, poor bud development and reduced cold hardiness, poor light interception and a decrease in yield potential in the following year. Undercropped vines, where large vines carry small crops, will exhibit excessive vigor that will warrant intensive canopy management to avoid shading of fruit and poor infiltration of spray material (Howell 2001).

Several management practices have a direct influence on crop load. As mentioned above, the first is pruning. The number of buds retained represent the potential shoots that will emerge in the spring and potentially set a crop. There is a pervasive trend to leave more buds than is reasonable as insurance against early spring frosts. If those frosts do not appear, as with the current growing season, shoot thinning allows vines to be brought back into balance. For many vineyards producing grapes that garner high prices, hand laborers may be able to appraise each vine and adjust shoot number accordingly. In vineyards that cannot justify the luxury of the human eye and human hand guiding each vine back into balance, how can balance still be achieved?

From Hands to Hydraulics, the Mechanized Solution to Shoot Thinning

As vineyard mechanization has become prominent in the Lake Erie region, solutions for many vineyard practices have come to market. Shoot thinning is no exception. Dr. Justin Morris worked collaboratively for nearly four decades before patenting the Morris-Oldridge vineyard mechanization system that was commercialized by OXBO International Corporation (Morris 2008). With funding from New York Farm Viability, researchers at CLEREL were able to secure two mechanized shoot thinning systems (Figure 2) from OXBO the V-mech line was sold to Midwest Grower Supply. The shoot thinning heads attach to a tool carrier that can be used interchangeably with attachments for pruning, shoot positioning and even fruit thinning.

Figure 2. OXBO International Shoot Thinning System with one paddle per side. Photo taken by J. Dresser, LERGP.

Flexible paddles are attached to each shoot thinning head, whose rotation is driven by a hydraulic motor. The number of contacts may be increased or decreased in three ways. Adjusting the hydraulic flow to the motors will change the RPM of the shoot thinning heads, which may be run with up to four paddles per side. Ground speed may also be adjusted to achieve the desired frequency of contacts along a vineyard row. In-field calibration is recommended, as planting density, shoot density and shoot length will all influence how the number of contacts made by the paddles will reduce shoot number. Four miles per hour is a good ground speed to start with, especially as the operator becomes familiar with controlling the tool carrier.

When hand labor is not available or affordable, mechanization is an alternative that allows shoot thinning to be accomplished efficiently with the intention of bringing shoot number per vine back into a reasonable range. The ideal shoot number, much like the ideal crop load may vary depending on cultivar, seasonal conditions, production goals, nutrient and water availability, disease and insect pest pressure and floor management. Depending on these factors along with vine size, shoot number may be targeted anywhere from 40 shoots per vine up to 120 shoots per vine. With the intention of helping provide some of the benefits of hand labor, namely assessment of vine size and adjustment of shoot number accordingly, while offering the efficiency of mechanization, researchers at CLEREL have been working to refine a protocol for variable rate shoot thinning.

Smarter Shoot Thinning

With an understanding of crop load and a mechanized shoot thinning system ready to go, the next challenge lies in how to (1) assess what shoot number each vine is carrying, (2) determine what shoot number each vine should be carrying and (3) use the shoot thinning system to make the desired correction in shoot number. Vine-by-vine mechanized management is still out on the horizon, but post-length by post-length mechanized management is achievable today with commercially available technology. The protocol used by CLEREL researchers can be broken into the following steps:

1. Use off-the-shelf canopy reflectance sensors (ACS430, Holland Scientific, Lincoln, NE) linked with positioning system at 2" shoot growth stage to get a relative idea of how shoot number varies throughout the vineyard.
2. Process and map sensor data and break vineyard up into management classes.
3. Stratify samples and collect manual shoot counts to characterize shoot number in each class.
4. Model relationship between sensor data and manual counts to convert relative map to absolute map.
5. Make management decision (how many shoots per vine are desired in each class?)
6. Calibrate shoot thinning system in vineyard to be thinned.
7. Code management decision into prescription map (SMS, AgLeader Technology, Ames, IA).
8. Just drive (the prescription controls the rate, operator controls steering, tool arm and ground speed)

In the first stage of the project, canopy sensors are attached to vineyard vehicles and pointed at the growth zone to collect reflectance data throughout the vineyard. This can be accomplished during routine spraying or mowing operations in the normal driving pattern used. The sensors emit white light from a molychromatic LED that is just strong enough to reach the canopy in the row it faces, but not to reach the rows beyond. This light is reflected off of the green tissue at different levels depending on the wavelength. The sensor has three wavelengths that is records reflectance at, as well as the latitude and longitude coordinate at the sensor position. This information can be integrated into a spatial map of a vegetative index called Normalized Difference Vegetation Index (NDVI). NDVI is a good indicator of shoot density at this growth stage. Looking at the map, the areas where NDVI values are higher correspond to areas with a higher shoot number per vine while areas where NDVI values are lower correspond to areas with less shoots per vine. The numeric value of the NDVI reading holds little value, but the patterns that are shown on the map (Figure 3) are crucial.

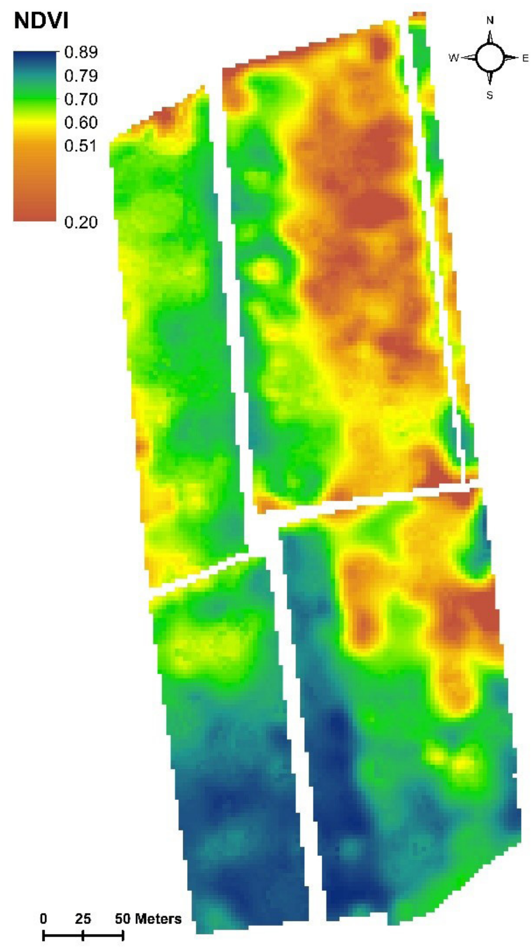

Figure 3: NDVI map of a commercial vineyard. Image by J. Dresser, LERGP.

After the sensors collect reflectance data, the next step is to create a spatial map. Raw data must be cleaned and processed before becoming a spatial map. Processing protocols have been established in the literature since the late 1990s and refined since (Bramley and Williams 2001, Paoli et al. 2007 REFS). First, a boundary is drawn around a vineyard block and a standard grid is created within it. Outliers and data points collected outside of the vineyard area are removed first. Then, values are predicted at the grid points to create a uniform surface to map. The sensors record a measurement once per second, so the spatial appearance of raw data points is erratic and not conducive to spatial mapping. After values appended to the grid points, a raster image may be created using GIS software. This is the stage most growers will see, a smooth map representing the spatial data collected in the field. To prepare for a practice like shoot thinning, theses maps must be taken a step further. The next step is to create management classes, which is done by statistically separating the values into groups, maximizing mean separation between the groups and minimizing variation within each group. These management classes will each receive a specific treatment, in this case a shoot thinning level.

Implementing management based on the relative NDVI patterns alone is not recommended. In-field validation is needed to see what the shoot number is within each management class and how much variation exists. It is possible that the shoot number varies widely between management classes, and it is also possible that shoot number does not vary much at all. The best way to validate the patterns shown on the spatial map is to go out and count some shoots. The more samples that are taken, the more confidence may be placed in the average shoot number in each management class, but ten samples of one vine each per class should be enough in most cases (Figure 4). If it is difficult to see vine separation, it is sufficient to count shoot number within a unit space equivalent to vine spacing.

Figure 4. Sample locations for manual counts. Image by R. Eckstrom, LERGP.

Once in-field shoot counts are completed, the range and average of shoot number per vine in each management class can be quantified. The averages in each management class may be enough to make a shoot thinning decision, but it may also be useful to see a smooth map of shoot number as the NDVI map appeared. In order to achieve this, the relationship between shoot number from the manual counts and the NDVI value from the sensor data can be modeled and used to translate the NDVI values to shoot number values. The shoot number values may be mapped in the same way that the NDVI values were in step 2.

Armed with a good idea of how shoot number varies throughout the vineyard and considering the average shoot number per vine present in each management class, the grower/manager can start the decision making process. Going back to crop load, the grower first needs to consider the vine size in each management class. Ideally, the grower/manager would know if each class contained one-pound, two-pound or three-pound vines and what their maximum yield should be (Figure 1). With shoot thinning, there is a little less certainty about the crop that will be set than with fruit thinning (which will be the topic of July's newsletter). The cluster number per shoot may vary along with the berry weight, which will influence yield. There is also a chance that secondary shoots will emerge after thinning, which may contain about a third of the crop that the primary would have carried (Martinson 2010). This is one of the reasons that crop estimation should be completed every growing season. After shoot thinning, crop estimation will provide the grower/manager with an indication about whether or not the shoot thinning that was undertaken was enough to bring vines into balance or if further adjustment, through fruit thinning is needed. All complicating factors considered, the grower/manager must decide what shoot number to target in each management class.

Once the desired rate of removal is known for each management class, the next step is to calibrate the machine in the field to determine what RPM is needed to achieve the target shoot removal rate for each management class. In field calibration is needed, especially as mechanized variable rate shoot thinning is in an early stage of commercial adoption, because shoot growth stage, canopy architecture, shoot density and machine set-up will change the results of a given RPM in the field. Consider that a set RPM will behave differently in the following scenarios. Scenario 1: 150RPM with four paddles per side on hand-pruned vines with 8ft vine spacing and 80 shoots per vine. Scenario 2: 150RPM with two paddles per side on machine pruned vines with 225 shoots per vine at 6ft spacing. While it may be possible to infer that these two treatments would result in less shoot removal in scenario 1, it is impossible to know just how many shoots 150RPM would remove in the two situations without testing the equipment in the field in both situations. As research in this area matures, it is not outside of the realm of possibility that algorithms could be created to reduce the importance of rigorous in-field calibration. However, I would personally recommend testing the machine on a representative row in each management class and at least count shoots before and after on a few vines before finalizing a prescription map and letting the operator go off on his or her way.

For research purposes, whole calibration rows are reserved in each management class and five rates are tested in each row (Figure 5). The shoot count on at least four vines is collected before and after thinning from the center of the length of row designated for each rate. This allows the relationship between RPM and % shoot removal to be determined. These relationships are used to code the prescription map used across the entire field. A field computer mounted in the cab of the tractor facilitates display and interaction with the prescription map. A flow controller synced with this map follows digital instructions to regulate hydraulic flow to the thinning head motors and, subsequently, rotation speed for each management class so that the operator does not have to worry about anything but keeping the machine where it needs to be while the desired shoot thinning level is achieved.

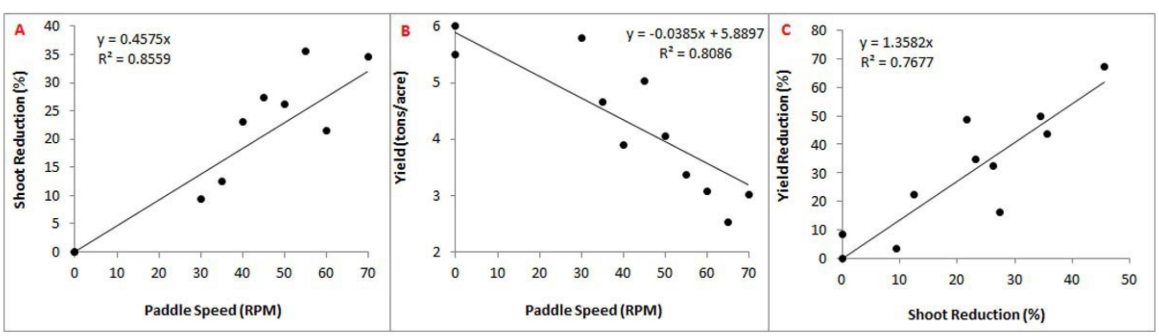

Figure 5. Rate calibration and evaluation for OXBO shoot thinning system. Image by C. Hickey.

While this protocol has been used in commercial vineyards in the Lake Erie region with good results (desired thinning level was achieved, crop load was reduced, ripening was accelerated), guidance from those with experience working with spatial data and precision viticulture systems (like a variable rate shoot thinner) is still part of the picture. A grower/manager is not expected to venture out on their own to implement this sort of management, especially at this stage of research and development. That being said, LERGP is well positioned to provide guidance to growers interested in making variable rate technology a part of their vineyard management plan and encourage those adventurers out there to reach out and discuss how to get started.

Out on the Horizon

The protocol outlined above exposes some major obstacles to commercial adoption of variable rate shoot thinning (or management in general). The first obstacle is the cost of the equipment used for the collection of spatial data. Global Navigation Satellite System (GNSS) receivers that are able to reliably track within a couple of feet horizontally cost thousands of dollars and combined with the sensors and data collectors that capture the reflectance values used in step 1 above, just gearing up to collect spatial canopy data could cost up to $10K. LERGP has made an effort to relieve this burden by offering a loaner sensor program free of charge to its members. Anyone who is interested in participating in this service is encouraged to contact LERGP at 716-792-2800 to get on the calendar for the 2018 season. A technician will install the sensors on the farm vehicle of your choice and provide training on data collection.

Even if a grower/manager is able to collect data with no economic implications, a second obstacle to adoption of variable rate shoot thinning exists. Data collected appears as intelligible lines on a lengthy spread sheet. To get raw data from a spreadsheet into a reliable visualization requires spatial data analytics skills and specialized software programs that are not common on the farm. To address this issue, the efficient vineyard (www.efficientvineyard.com) team is in the process of building a spatial data platform where raw data could be uploaded and converted into a spatial map with additional decision support. This would help early adopters jump from step 1 to step 3 in the protocol above.

Additional barriers to adoption accompany much of the statistical analysis needed to achieve desired shoot thinning results in the field. The intensive calibration procedure needed to tune the equipment may be something that is reduced through efforts in the commercial and/or research space as the technology matures and algorithms are achieved that may be tailored to the wide spectrum of vineyard parameters. While manual shoot counts are an essential part of the variable rate shoot thinning protocol in its current form, imaging technology under development at Carnegie Mellon University (Figure 6) as part of the efficient vineyard project may remove this burden and replace steps 1-4 by quantifying shoot number across a vineyard in one pass.

Figure 6. Imaging system prototypes designed by Carnegie Mellon University. Image from efficientvineyard.com

To be continued

Research trials using variable rate technology to thin shoots mechanically in commercial vineyards are currently underway in the Lake Erie region. Results of these trials will be shared through the LERGP weekly podcast series, written crop update articles, field demonstrations and through website materials found on lergp.com and efficientvineyard.com, grower conference presentations and beyond. Those interested in learning more about this technology or seeing it in action are encouraged to (promptly) contact us at 716-792-2800 or reach out through our website or social media pages.

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LERGP
2018 COFFEE POT MEETING SCHEDULE

Date	Time	Location	Address
May 2, 2018	10:00am	Clover Hill Farm	10401 Sidehill Rd. North East PA 16428
May 9, 2018	10:00am	Ann & Martin Schulze Winery	2090 Coomer Rd. Burt NY 14028
May 16, 2018	10:00am	Sprague Farms	12435 Versailles Rd. Irving NY 14081
May 23, 2018	10:00am	NE Fruit Growers	2297 Klomp Rd. North East PA 16428
May 30, 2018	10:00am	Double A Vineyards	10277 Christy Rd. Fredonia NY 14063
June 6, 2018	10:00am	Fred Luke Farm	1755 Cemetery Rd. North East PA 16428
June 6, 2018	3:00pm	Thompson Ag	Corner of Hanover and Dennison, Silver Creek NY 14136
June 13, 2018	10:00am	Jim Vetter Farm	12566 Versailles Rd. Irving NY 14081
June 13, 2018	3:00pm	Jerry Chessman Farm	11725 Middle Rd. North East PA 16428
June 20, 2018	10:00am	Duane Schultz	3692 Wilson Cambria Rd. Wilson NY 14172
June 20, 2018	3:00pm	Brant Town Hall	1272 Brant Rd. Brant NY 14027
June 27, 2018	10:00am	Betts Farm	7365 East Route 20 Westfield NY 14787
June 27, 2018	3:00pm	Beckman Farms	2386 Avis Dr. Harborcreek PA 16421
July 11, 2018	10:00am	CLEREL	6592 W. Main Rd. Portland NY 14769
July 18, 2018	10:00am	Tom Tower Farm	759 Lockport St. Youngstown NY 14174
July 25, 2018	10:00am	Ziesenheim	8760 W. Lake Rd. Lake City PA 16423

INSURING GRAPES

NY, 2018

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Important Insurance Deadlines

- **Nov. 20, 2017:** Sales Closing, Policy Change, Cancellation, Termination Date
- **Jan. 15, 2018:** Acreage / Production Report Date
- **Aug. 15, 2018:** Premium Billing Date
- **Nov. 20, 2018:** End of Insurance Period

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Erie
Niagara
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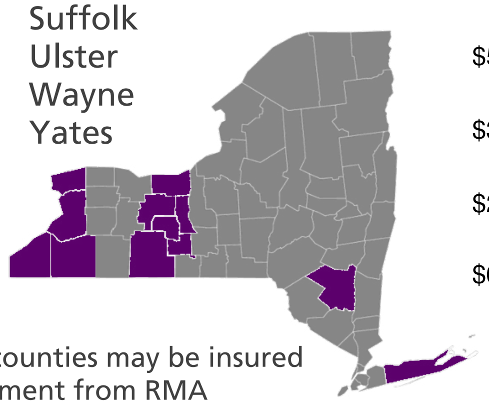

Grapes in other counties may be insured by written agreement from RMA

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Cornell University delivers crop insurance education in New York State in partnership with the USDA Risk Management Agency.

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Cornell University
Cooperative Extension

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