



## Rain at Harvest: finishing the end game



September is crunch time in the vineyard, it's time to hurry up and get the fruit ripe. To a grape grower few sounds are as distressing as the pitter-patter of raindrops during the harvest season. As important as late season weather is to wine quality, there is pitifully meager information about it. I looked through a dozen major viticulture textbooks from Australia, France, Germany, and the U.S and as important as post—veraison weather is to wine quality, I never found more than a paragraph about rain at harvest. Having worked in Oregon, Long Island and now the Mid-Atlantic, rain is a something I naturally think about at harvest, even in a relatively dry

season because it's never further than a hurricane or low pressure system away. In sensible growing regions (see: dry/warm), they don't worry much about rain but when it strikes they panic and run screaming into the hills, not exactly a constructive reaction when making wine. The calm among our wine makers in years like 2005, 2009 and 2011 is a bit unnerving, if not surreal (or maybe we are all just in complete denial). Regardless of each individual's response to rainy harvest conditions, the need to harvest the best quality grapes remains paramount. Our colleagues in Western Europe are probably the best at coping with post-veraison rain but their episodes are usually not as frequent or significant as ours. Wine from Burgundy and Bordeaux, two potentially damp wine regions of some note have improved and become much more consistent in quality over the past two decades because of climate change, but also because they have figured out how to cope with wet vintages, both in the vineyard and cellar. All wine growers would rather have a warm-dry harvest but that will never be the reality here. I wish the French and Germans would write about this topic in detail so we could learn from their experience.

The coastal areas of the eastern U.S. are particularly vulnerable to wet events. Hurricanes are a threat from June to December. Low pressure systems that sweep or stall over an area can dump as much rain as a hurricane (see October, 2005). The pressure these events place on wine quality is enormous, and at some point the prudent wine grower has to ask how much is too much? There are many passive and active viticultural factors that will influence the outcome of adverse conditions. The better a vineyard and vintage is planned and designed to handle rain the more likely a good wine can still be made.

From a physiological perspective it is interesting to consider how rain gets into the berries. When I was a grower in Oregon we always assumed that it was taken up by the roots and eventually exited the same way. Research done by Dr. Markus Keller at Washington State University on Merlot and Concord has shown that root uptake is not the primary means of water intrusion into the berry but instead diffusion across the berry skin is the major pathway. More recent research in Germany (Becker and Knoche) has demonstrated that water uptake is through an unidentified pathway associated with the berry stem receptacle and transpiration is through the berry skin. If these explanations are true, then any means to physically prevent water from reaching the berries will be helpful to preserve its integrity. New Zealand has a system of folding awnings that can be installed on trellis systems that divert water away from the

canopy into the row middles. Perhaps even bird netting may help to reduce water penetration to the fruit zone.

Mitigating the effects of harvest rain begins with site selection and a vineyard with good drainage balanced with sufficient water holding ability to satisfy vine water and nutrition needs in wet, dry and all the conditions in between. This can be achieved with natural or artificial means. Good soil physical qualities can be quantified by a method like the Total Available Water (TAW) system used by the soil viticulturists in California. They analyze and rate the drainage qualities of a site. Slope is another feature that can have a very positive influence on both subsurface and surface drainage, and steep slopes can offer dramatic surface and subsurface drainage capabilities. However, a flat or gently sloped field with just the right soils can perform very well with proper care. These are durable features of a vineyard and will always benefit the wine being grown on the site. Be aware that erosion problems increase with steeper slopes. The flip side (there always is one in viticulture) is that in dry years, like 2010, is that water availability, not removal, that can cause water stress in grapevines, can harm quality just as much as too much water. There is a real tug-of-war between too much and too little, and getting it just right in our rainy climate is as much a matter of luck as any viticultural skills we can apply to a site. “Just right” only happens in arid wine regions that can meter in just the right amount of water to satisfy vine needs and push fruit ripening. In natural systems this is a much more difficult scenario to achieve.

French drains and drain tile can significantly improve the drainage ability of a soil. They are used very effectively on the clay soils of the Niagara Peninsula. If a soil survey indicates poor drainage features, then tile is almost essential. But they can help even in superior conditions. Drain tile must be properly designed and installed to the particular features of a site. A hydrologic engineer should be used to develop a suitable system. As a general rule, any working system that is buried such as irrigation or tile, must be properly designed and installed because it is so difficult and expensive to repair if something goes wrong later on.

After ten years of listening to growers and watching storms track across the region I am pretty convinced that there are rain shadows that can be exploited for wine growing but my evidence is meager. Chester County vineyards seem to get more rain and hail, while Adams and York counties are distinctly drier through the summer months. How fine this shadow effect can be analyzed and mapped is yet to be determined but I am pretty sure we have the data and technology to do it. James Fisher, a vineyard soil consultant in Pennsylvania has used NASA data to look for patterns of precipitation in the region but so far it looks sketchy. The best strategy at this point may be to ask old timers for their ideas about the places that the clouds avoid. If soil and climate mapping can be merged to pick the best of both then the potential for more consistently fine wines is the logical outcome.

Grape varieties respond differently to rainfall at harvest. If you just say “rain” in a Cayuga white vineyard the berries will split. There are some products used by cherry growers that can be sprayed onto clusters to protect berries from rain. Tight cluster varieties like Chardonnay, Sauvignon Blanc, Riesling, Pinot Gris, Vignoles are well known for their propensity to rot, whereas Albarino appears to be a very durable white variety. Pinot noir is very sensitive to moisture whereas Cabernet Sauvignon and Petit Verdot are very durable and almost indestructible. Without a doubt thickness of the skins and looseness of clusters are factors in a variety’s relative susceptibility to splitting and rot due to late season moisture. If you know your site is a wet one, choosing suitable varieties will really help. As a general rule, reds need more time to ripen and go deeper into the season expose them to more weather risk. Red wines need maturity to make good wine. On the other hand, whites generally ripen earlier and can make decent wine over a wider range of maturity so they are more flexible and tolerant of adverse weather conditions.

Getting the grapes off the vine before the rains move in should also be in the vineyard design and development plan. Shortening the vegetative cycle of the vines will also help with vine acclimation and cold hardiness. Quality of site will impact this process but so will the choice of variety, clone and rootstock, as well as vine density, spacing, and trellis and training system choices. Vines with low to

moderate vigor on higher density spacing tend to ripen earlier and lower yields per vine help to promote the more rapid maturation of the fruit, especially if yields are properly managed. Training systems that create an optimal condition for ripening along with proper row orientation will all help to push the harvest forward. If the wine goals for the vineyard support these design features it can help to keep the grapes from late season rains.

One of the best things you can do to preserve quality in a rainy vintage is to keep your fruit clean and sound. The ultimate objective of the wine grower is to harvest fruit when it ready and not to be forced to pick earlier due to any of a host of external factors that can push a picking decision. Any imperfections in the skin, whether caused by diffuse powdery mildew, botrytis, a bird peck, grape berry moth, or a bee will speed the deterioration of the grapes once it is wet. Most growers associate rain with disease problems especially for botrytis and other late season rots (bitter, ripe and sour) in our climate. In a dry year the overall disease pressure is greatly reduced. In 2010, the front end of the vintage was wet and cool with signs of early botrytis that may have caused more trouble if the post-veraison period was also wet. But it was dry enough that botrytis never got a firm toe-hold and some of it even matured into “pourriture noble” or noble rot, a favorable form of botrytis responsible for Sauterne and late-harvest German wines. But growers need to be ready to defend the grapes against late season disease threats with all available measures, especially optimal fruit zone and canopy management practices. Experience counts a lot in all late-season viticulture decisions because there is not enough time left in the season to amend a mistake. Proper yield adjustment, leaf removal/fruit exposure, spray applications, and all the veraison-period decisions will all have an impact on wine quality. The smell of acetic acid in the vineyard is one of the most disheartening sensory clues that a vintage has been compromised. Bees, ants, birds, stinkbugs, lady beetles and any creature, organism or natural cause that breaches the integrity of the berry skin contributes to the loss of quality.

In my experience bird pressure in vineyards is always worse in wet years, although it seems like every year is a bad year for birds now. A sound strategy to reduce bird damage to a minimum is necessary, not only to reduce yield losses but to protect the clusters from disease caused by bird injury to the grapes. In a season like 2011, which began with early and severe bird pressure in many places, the only real solution is to use bird netting on the vines (see a related article on bird control). Side nets are becoming more popular because even when in use sprayers and hedgers have access to vines and they are easier to install and remove.

A balanced vine will promote fruit ripening. Proper canopy and crop management will enhance maturity. These practices are the foundation of a sound integrated pest management program. However, in wet vintages cultural practices must be supplemented with a thoughtful and well-executed spray program. It begins with the date of bud break and anticipating when the harvest season will occur – early, normal, or late? Tailor your vineyard management and IPM to the seasonal conditions and anticipate what may happen in the vineyard months ahead. In 2011, bud break was very late offering the possibility of a late harvest with all its challenges. The bloom period was also very wet and cool which provide ideal conditions for latent infections for many of the fruit rot diseases. A fruit rot program should be tailored to these conditions, in this case four applications at bloom, bunch close, veraison, and veraison + 2 weeks would be prudent. After veraison, if conditions deteriorate, apply sprays before rain events. If rain exceeds 2” then reapply. Adjust spray intervals according to conditions and know the most effective products to use but be cautious of pre-harvest intervals, disease resistance and effects of materials on fermentation.

You need to know about the weather to know what to do about it. I’m pretty sure that wine growers care more about the weather than anyone in agriculture. While it’s not possible to change the weather there are more resources than ever available to forecast it, and this should help the harvest planning process. 2009 and 2010 are shining examples of the variability of conditions from one vintage to the next in our region, much less trying to measure the impact of climate change on viticulture. And we shouldn’t forget the October low pressure system that stalled over the East in 2005 (20” of rain in 8 days on Long Island).

Grape growers need to know the weather from a few hours to a few days and even weeks to properly plan for the harvest. A decision to pick (or not to pick) sets in motion a long chain reaction of events in the vineyard and winery and, therefore, the decision is made with extreme care. With satellite data and imagery it's easier than ever to track the weather but the need for forecasting a few days to weeks out is important to wine growers trying to decide whether to let grapes hang or harvest them. Forecasting models are numerous, variable and inconsistent. Even with the use of sophisticated software and Cray supercomputers forecasting is still an inexact science. The Penn State meteorology department offers long term forecasts based on many different models and each week the spaghetti graphs of the jet stream are a variable as, well, the weather. Most growers have multiple weather forecasting sources such as Weather Underground, the Weather Channel, WeatherBug, and NOAA, that they use to gather data, cross-reference and try to base their harvest decisions on. Experienced growers rely on their own intuition based on local experience to predict upcoming conditions. The best growers can sense changes in weather patterns that allow them to respond with their picking decisions. No scientific explanations here - just that sixth sense that farmers develop over time.

There are different responses to a deteriorating vintage based on whether a vineyard is an independent or estate vineyard, if a grape contract is tonnage or acreage, and just what the intent of the grape is (production or boutique, price-point, market, etc), are all important considerations of what and how much may be done to push and preserve grape quality. As a rule, independent growers want to pick the fruit too early to make the best possible wine. They are also prone to over-cropping, a condition that can exacerbate all kinds of wine quality and viticultural problems. Wine makers want to let the fruit hang until ripeness is achieved with little regard to the conditions or sanity of the grower. There is a lot of room between "get it in ASAP" and "making the best wine possible." Every grower has to figure out where he or she fits on this continuum. This involves serious and regular communication between grower and wine maker. Winemakers should clearly understand the integrity of the fruit and conditions in the vineyard. Growers should be fully aware of the type and style goals the wine maker has for the grapes being made into wine. Everyone should be willing to compromise.

Pinot noir is a delicate grape and very sensitive to changes in its environment. In Oregon, we lived in fear of harvest rains that would dilute sugars and flavors and cause disease problems. It was assumed that water was taken up by vine roots and transported into the berries. Recent work by Dr. Markus Keller at Washington State University provides an alternate explanation of how water arrives in the berry. His research demonstrates that water moves across the skin into the berry. I had heard growers on Long Island describe how they position leaves over clusters in order to shield them from rain. If Dr. Keller is correct, this practice makes a lot of sense. Dr. Keller's research is compelling and logical but it goes against the widely accepted view that water is entering through the roots. In a place like Pomerol where rain can be a problem at harvest, Chateau Petrus was well known for having covered a large area of its vineyard with plastic to exclude rain from the soil. A well-respected winery on the North Fork of Long Island has done this using heavy-duty black plastic on a block of old vine reserve quality Cabernet Sauvignon and while I have never tasted the results they insist that it makes a positive difference in wine quality. Intuitively, this practice makes sense but I am not aware of any research that explains the cause/effect. Plastic may actually make the soil environment more humid and anaerobic. The heat absorption of the plastic and subtle microclimate change may also have an impact on vine physiology with implications for ripening.

The question always boils down to "when do I pick the grapes?" Clearly the maturity indices and condition of the fruit are critical to the making the decision. Harvest logistics also factor in but anything not directly supporting the production of the best wine possible should be a secondary consideration. A little bit of clairvoyance or a lot of experience with harvest weather, and as much weather information as possible will help guide a decision. Input from the wine maker is also crucial. Should growers pick in the 24-36 hour window between storm systems or wait it out and pick after a recovery period and into better weather (if it appears)? This is the most difficult decision in the business.

Agriculture in general and wine growing in particular require a heightened sense of risk assessment and tolerance that makes the stock market look like child's play. Hold them or fold them? The goal of wine growers is to pick fruit when it can make the type and style of wine assigned to it. But grapes don't always make it to the finish line here and deciding just how far from that line to throw in the towel is a complicated and important decision. There is no easy answer that I know of. The question that cannot be answered is how long does it take for a diluted berry to recover to its original condition (sugar, flavors, phenolics, etc.) prior to the rain event and then continue to make progress towards optimal maturity? It depends on the severity of the event and the soil and fruit condition immediate prior to the event. In 1999 Hurricane Hugo dumped 10" in one day on the Mid-Atlantic. In 2005 Long Island took 20" in a week. Both were devastating events for the harvest and extreme examples of the kind of weather we can face at a critical time in the vintage. However, in both vintages, very nice wines appeared. How was this done? I wish someone had attempted to record and analyze the response to the storms that resulted in good wines. Severity and duration of a rain event along with soil and fruit condition will determine the impact of the event on quality and the response. If the soil is bone dry prior to a rain event it would take a significant amount of rain to penetrate to the roots. Rooting depth is also a factor. In the Left Bank sand over clay is not favored because the water moves too quickly towards the roots. In drip irrigated vineyards the roots mainly occupy the irrigated zone. I can think of two root scenarios but I don't know which is realistic or better - shallow rooted *Riparia Gloire* that will allow the water to move past the effective rooting zone and dry out towards recovery or deep rooted 3309C that will grow below the water penetration zone. In Oregon growers would typically allow 3-4 days for grapes to recover after a 1-3" of rain, not an uncommon occurrence, but then more clear weather is needed to push ripening forward, so actually a week or more of good weather is necessary for grapes to recover and continue the march towards maturity. In September, and especially in October, a week of good weather can seem like an eternity and the probability slim to none. I always viewed the situation in terms of "how many steps forward" vs. "steps backward." If the grapes can go two forward (ripening) and one back (rain) then at least there is a net gain in quality, but when they are going one forward, one back, it's time to consider options. When playing the weather game results in one forward and two back, then it is time to look long and hard at the fruit quality, weather forecast, and picking schedule. Knowing when the fruit is back to the starting line is no easy matter. The numbers can tell part of the story but as the season gets later, brix accumulation slows and is less reliable as an indicator. Fruit sensory features, particularly flavor profiles, are the main quality variables. This is when having an experienced wine maker's palate in the field can be extremely useful. Fruit condition in our region often determines when the grapes are harvested but this is a compromise that is made grudgingly. Berries will reach a point when they have simply been beaten up so much by adverse conditions that they break down, eventually turning to mush. Symptoms of this degradation are visual, tactile, and sometimes even aromatic – the berry skin loses its bloom (the white "dusty" appearance becomes dark and oily) and begins to soften, if not shrivel. These conditions may be accompanied by acetic acid aromas. Certainly when berries are falling off the cluster and rolling down the hill, they are trying to tell you something. If disease, birds and all the other threats to the fruit have affected the quality enough that hanging them any longer will mean a net loss in wine quality, they have to come in. All of this is based on a complex network of chemical, sensory and intuitive evaluation. New growers should rely more on the statistical indicators that the grapes are ready. With experience and an increased tolerance of risk some growers can push the fruit further on the vine. After the 20" event in 2005 on Long Island a lot of the fruit turned to mush. But some growers were able to protect and recover some grapes that made very good wines. Each success story I have heard is based on experience and the ability to respond quickly to predicted and existing conditions.

Which will make better (or worse) wines, grapes that are unripe or grapes with disease or other imperfections? Every wine maker in the East must be prepared to make this decision and act on a moment's notice. For example, wine growers had 2-3 days to prepare for the arrival of Hurricane Irene in August – early in the harvest season but nevertheless potentially lethal to wine quality. The unequivocal answer is that a wine cannot suffer both insults – immature and diseased fruit. This is where the wine makers earn their keep. Growers know what they must do in the vineyard but no one can predict the impact or outcome of a nasty weather situation. It takes nerves of steel to work in these conditions. If fine

wine is made it is a tribute to the work earlier in the season by the grower, the skill of the wine maker and communication between them during the growing season but especially near harvest. There are some practices that can help to preserve fruit quality in rainy conditions.

- Rain is only one factor that forces growers to pick fruit before it is fully mature. Others include disease, birds, and frost. All will compromise wine quality if they shut down the vintage early. Keep fruit protected and clean, i.e. use nets and keep spraying even after veraison.
- Too much moisture on the fruit can be as bad as in the soil. Pick the grapes when they are dry. That may be difficult in our humid conditions with morning dew. If it rained at night, wait for the fruit to dry. Leaf blowers can be used to blow moisture from the clusters and canopy prior to harvest.
- Do not let rain accumulate in grape bins. If it starts raining, bins need to be covered or moved under cover. Should macrobins have drain holes or not? That is a perennial question. Some varieties juice more than others and that juice is lost. But if it rains, it is certainly helpful to allow the water to drain. Some growers have used holes with plugs.
- Manage your yields carefully. This has to do with getting the grapes in the barn as soon as possible. Over-cropping will delay ripening and expose the fruit to more risk on the vine.
- Harvest fast. In some situations a machine harvester is the most expedient tool (and expensive). But if it is an option it should be in the decision loop. If not a machine, then a large enough, skilled crew of pickers (i.e. not friends, family, Kelly girls, etc.).
- Sorting fruit is really, really important, not just for stinkbugs and lady beetles but also rot and unripe fruit. I can think of few vintages in the past dozen that would not have benefited from fruit sorting, even the dry ones. Sort as often as can be tolerated - in the field and on the crush pad (if possible before and after the destemmer). Good wine can only be made from good grapes so get the bad stuff out. See Nelson Stewart's excellent article on sorting grapes under the Viticulture Documents tab.
- I used to think gadgets like concentrators and rotary fermenters were a form of cheating in the cellar. Now I believe they are no worse than using irrigation in an arid region. A few years ago Parker gave these wine making gizmos his stamp of approval. They are widely used in Bordeaux as a tool, but the wise vigneron does not depend on them as a crutch. I have been told that if used properly, they may help raise a declassified wine to a second label, but never a second to first. They can just as easily ruin a wine as help it if used improperly. I have tasted some 2009 red wines that were made using a rotary fermenter and they clearly have more depth and concentration than other reds from this difficult vintage. Gino Razzi at Penns Wood Winery told me that he think 75% of all wines would benefit from the proper use of a rotary fermenter. Saignée is the traditional method for dealing with grapes that have been diluted by rain and can work well if done correctly.

A key objective of any self-respecting wine region is to produce consistently fine wines regardless of vintage conditions. Consumers don't really care if it rained or not in the fall, they want a good bottle of wine. In the Mid-Atlantic, we have chosen viticulture in a wet climate. If we cannot figure out how to deal with it then our wines cannot succeed at a consistently high level of quality. It may be that every grower is on his or her own when it rains. I would like to think that there is a sensible and predictable response to rain at harvest. If anyone who reads this has ideas, suggestions, comments or criticisms, or knows about any research about the subject of rain at harvest I sure would appreciate your input.

Mark L. Chien  
Viticulture Educator  
Penn State Cooperative Extension  
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<http://pawinegrape.com/>