

Viticulture in the Willamette Valley, Oregon: creating a predictive model to estimate the incentives of biodynamic viticulture



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Abstract

Biodynamic agriculture and certification in viticulture has become increasingly prevalent among growers in Oregon and globally within the industry. Recent studies have concluded that biodynamic viticulture improves the sensory experience of the wine and health of the soil. During a field course in Oregon, viticulture was analyzed in the Willamette Valley of western Oregon. Keeler Estate, Illahe, and Adelsheim Vineyards were selected based on Low Impact Viticulture and Enology (LIVE) certification and primary production of pinot noir grapes. Keeler Estate Vineyard was selected as a case study to analyze the effects of biodynamic viticulture on mineral additive reduction. A comparative analysis based on Keeler Estate Vineyard was applied to Adelsheim and Illahe Vineyards to estimate the improvements to be expected if biodynamic practices were adopted. The intended result of this analysis was to examine the processes of biodynamic farming to determine if the additional biodynamic certification reduced mineral additive usage and enhanced marketability and profitability of the product. After conducting the research, hypothetically 4,500 pounds were diverted over the 2011-2014 seasons, which is an indication that biodynamic certification reduces mineral output. This biodynamic sub-industry fits the Triple Bottom Line business approach, which tends to result in profitable business.

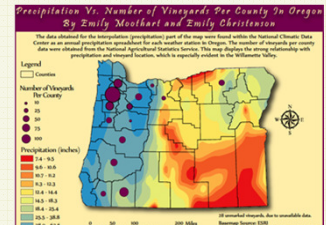
Literature Review

While researching for this project before visiting Oregon, it was determined that there are few comparative analyses on sustainable and biodynamic viticulture. Based on the other study's outlines, we wanted to develop our own research strategy. Biodynamics encompasses organic, sustainable, and further environmentalism such as displacing the monocultural tendencies of commercial farming by instituting insectaries and native plant refuge islands. These refuges can serve as 'biological control agents' and as a place to restore a natural biological habitat (Olmstead, M. 2014).

It seems that much of the hesitation to develop biodynamic land is due to its intensive processes that require more labor and dedication. Instead of producing for the masses, grapes are produced primarily for quality. Any change on viticulture can be detrimental because of the sensitivity of the crop. This is where preparations and fertilizers come into play. Biodynamic preparations are a non-toxic and naturally derived form of land enhancement that does not negatively contribute to runoff. In Spain, a comparative analysis was conducted to determine how effective various treatments of the land are. Biodynamics exceeded all other forms of land development, except in the area of "land competition" (Villanueva-Rey, P. et al. 2014). According to the Triple Bottom Line framework for modern business success, established by John Elkington, three components need to be addressed. These include making a business "environmentally sound, socially equitable, and economically viable" (Pullman, M. E. et al. 2010).

Beyond aesthetics, research has been done in California to test the physical differences between biodynamic and organic viticulture. The largest differences present were in the average pruning weights, with the biodynamic treatment having an optimal vine balance for high-quality grapes. The biodynamically grown grapes also tested with higher levels of sugars, total phenols, and total anthocyanins, all of which affect the color, taste, and texture of the wine (Reeve, J. R. et al. 2005). Other tests have been conducted to establish quality of the taste of the wine itself between organic and biodynamic wines. Throughout the study, blind comparisons were done on the basis of taste and preference, and although there were no cut and dry answers, of the 10 pairs of organic/biodynamic wines, biodynamic wine was chosen 8 of the times. Much of the disputes over which wine was better were seen to be more about preference than one thing in particular. In analyzing this paper, it has become more evident that there are a lot of factors, like flavor and harvest year, that affect people's preferences (Ross, C.F. et al. 2009).

Reference Map



Map showing the relationship between vineyards and precipitation in Oregon

- This map depicts the reason that the Willamette Valley (northwestern Oregon), more specifically the northern Willamette Valley was chosen as a basis for our research.
- The proportional symbol shows the number of vineyards per county and the interpolative precipitation map depicts annual rainfall in Oregon.
- From this map, one can see that vineyards are located in the second wettest locations in Oregon and thrive largely in part because of their proximity to the Cascade Mountain Range.

Methods

The selected vineyards, Keeler Estate Vineyard, Adelsheim Vineyard and Winery - Calkins Lane, and Illahe Vineyard and Winery, were chosen on the basis of their LIVE certification, primary production of pinot noir grapes, and location within three separate AVAs. Keeler Estate Vineyard has ten blocks of pinot noir grapes, which accounts for 56.2% of the total planted acres. Keeler Estate Vineyard was chosen as a case study due to the participation in biodynamic viticulture, which is unique among the chosen vineyards. Data were obtained from Keeler Estate Vineyard, including all of the inputs, outputs, and yields from the 2011 to 2014 season, seen partially in figure 1.

The crop material input record data were used to compile a dataset of all mineral and other additives applied to the soil each season. The total quantity applied was calculated by multiplying the rate of application (varying units per acre) by the number of applications per season. The per acre application total was multiplied by the total planted acres, to result in the total application per season. The following minerals were observed as decreasing from 2011 to 2014: boron, calcium, magnesium, and potassium. The total amount applied from 2011 to 2014 of each of these mineral additives was calculated and recorded.

A hypothetical situation was created that assumed that Keeler Estate Vineyard applied boron, calcium, magnesium, and potassium at the 2011 mineral additive application rates for the 2012, 2013, and 2014 seasons. The total hypothetical amount applied from 2011 to 2014 of each of these mineral additives was calculated and recorded. These totals indicate what would have been applied, had Keeler Estate Vineyard not continued to decrease the total mineral application. The difference between the hypothetical and actual totals was calculated as an amount of diverted material, as seen in figure 2. The amount of diverted minerals per acre was calculated to be used in the predictive model. The possible amount of diverted material was calculated for Adelsheim and Illahe vineyards using the predictive model, see figure 3.

Year	Potassium	Humus	Calc	Magnesium	Boron	Calcium	Fish Fertilizer	Nitrogen	Regalis	Sulfur
2011	9	4	8	0	4	5	4	1	1	1
2012	10	0	0	0	0	0	0	0	0	0
2013	11	0	9	4	0	0	0	0	0	4
2014	7	0	9	7	0	0	0	0	0	3
Total	37	4	17	11	4	5	4	1	1	8

Figure 1 - Raw mineral additive data received from Keeler Estate Vineyard.

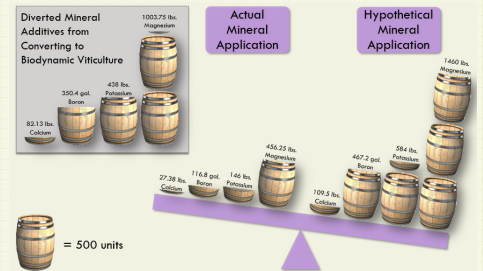


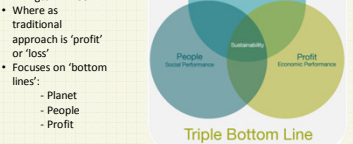
Figure 2. Keeler Mineral Additives. Calculation of actual use of mineral additives with biodynamic preparations, estimated additives using 2011 pre-biodynamic mineral additive application, and diverted mineral additives over four years after practicing biodynamic viticulture.

What is Biodynamics?

- A paradigm shift from "traditional" agriculture
- The use of biodynamic preparations to aid soil, plant and compost health
- Being mindful of the Earth's rhythms and cycles
- Treating the land as a single organism

What is the Triple Bottom Line?

- New business approach
- Developed by John Elkington in 1994



Objectives & Research Questions

- Complete a comparative analysis of the benefits that biodynamic farming can have on currently LIVE certified vineyards
- Develop a Triple Bottom Line business approach on the benefits of biodynamic viticulture
- Provide Keeler Estate Vineyard with information to use in marketing strategies and promoting biodynamic viticulture
- Encourage LIVE certified vineyards to move toward this market

Research Questions

- What biological factors play the largest role in plant health and wine grape quality?
- In what ways does the biodynamic approach relate to the Triple Bottom Line framework?
- What benefits could be expected for vineyards that convert to biodynamic viticulture?



Analysis of Results

The results of the analysis is a scenario in which a LIVE certified vineyard could see a seventy-three percent reduction in the amount of boron, calcium, magnesium, and potassium added to the soil. This predictive model can be used to estimate the reduction of mineral additives for vineyards in the Willamette Valley. Keeler Estate Vineyard diverted roughly 1500 pounds and 350 gallons of mineral additives over the course of four years by adopting biodynamic practices. A predictive model was applied to Adelsheim and Illahe vineyards using the same agricultural formula.

In the analysis of the soil and input records from Keeler Estates Vineyard, there was a trend of reduced mineral application to the soil and foliage from 2011-2014. This not only leads to reduced overall cost of operation, but a more natural management of the land. With biodynamic practices, the land is able to sustain its nutrients, allowing the soil to become more self-sustaining.

Arbuscular mycorrhizal fungi (AMF) are another integral aspect of plant and soil health especially in low input environments. The fungi form a symbiotic relationship with plant roots and aid in the uptake of minerals including zinc, copper, and nitrogen. Studies have shown that the main benefit to the plant is that there is an increased ability to uptake phosphorus and withstand insects and drought. The lack of mineral additives that allows this relationship to develop is seen as a benefit of biodynamic agriculture.

Since establishing the vineyard, Keeler has never explicitly added nitrogen to their land. This is due to their continual use of locally organic dairy cow compost that provides the soil with a more natural way of application. This allows the nitrogen levels to stay up without specifically adding the micronutrients to the soil. Through the prevention of intentional nitrogen additive to their land, Keeler Estate is reducing eutrophication or the process in which nutrients are unintentionally added to water, which can lead to algal blooms and fish kills (Gilbert et al. 2014).

Although soils need potassium, in recent years, it has become one of the most expensive micronutrients to purchase. With the soil tests run at Keeler Estates Vineyard, it has been shown that their biodynamic land management has allowed them to stop purchasing this micronutrient (Funderburg 2010). They originally added potassium in 2011 and discontinued applications for the subsequent years. From plant tissue analysis, we found that the percent potassium within the plant decreased initially in 2012, dropping from 2.26% in 2011 to 1.68% in 2012. However, since 2012 the potassium levels increased to 1.9%, even though no potassium has been added to the soil or vines. This could be due to the potential increase in mycorrhizal fungi that assist the plant in taking minerals.

One of our research questions was how does Biodynamic viticulture fit into the Triple Bottom Line business approach. This approach focuses on three main areas: planet, people, and profit (Slaper et al. 2011). Regarding the planet, it should be clear by now that biodynamics is one of the most environmentally friendly businesses. Not only are they saving rehabilitated animals, but they are reducing their carbon footprint each year by using less and less biodynamic preparations.

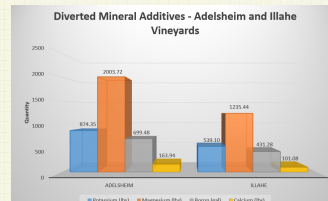


Figure 3. The graph above shows the predicted mineral additives diverted over four years if Adelsheim and Illahe vineyards were to convert from LIVE certification to Biodynamics.

Limitations

- Unable to do our own testing at the vineyards
- Young grapes can produce higher yields
- Not every aspect of sustainable vineyards in Oregon can be analyzed
- Personal preference of taste and aesthetics is subjective to wine satisfaction



Conclusions

- Currently organic vineyards could reduce mineral additives by up to 73% over four years
- Presumably seen as a better marketing stance
 - Saves money
 - Raises marketability
 - Captures a niche market
 - Puts less mineral additives into the soil
- Environmentally sustaining
- People focus
 - Community involved
 - Sharing the land as an experience

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