LODI RULES for Sustainable Winegrowing

Sustainable Farming Practice Standards Contributing to Measurable Greenhouse Gas Emission Reduction in Viticulture: carbon dioxide (CO_2) and nitrous oxide (N_2O)

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Best scientific review paper on the topic to date:

Longbottom, ML, and Petrie, PR. Role of vineyard practices in generating and mitigating greenhouse gas emissions. *Australian Journal of Grape and Wine Research*. 21: 522-536. 2015.

In summary:

- About 98% of greenhouse gas emissions in viticulture come from fuel and electricity use, with the remaining 2% coming from nitrous oxide.
- Nitrous oxide emissions are low in viticulture when compared with irrigated annual crops, likely due to the efficiency of nitrogen application to the roots of vines (fertigation) during periods of root growth.
- Nitrous oxide has about 300x more global warming potential than carbon dioxide. It slows the ability of Earth to radiate energy back into outer space and depletes stratospheric ozone. It is released in soil when microbes undergo nitrification and denitrification. Nitrification is generally a more significant contributor in viticulture.

Farming practice	Decreases net emissions of
Reducing electricity use	carbon dioxide
Reducing carbon-based fossil fuel use	carbon dioxide
Reducing the amount of nitrogen applied to the vineyard	nitrous oxide
Timing of nitrogen fertilizer applications	nitrous oxide
Increasing plant biomass aboveground	carbon dioxide
Increasing organic matter in soil	carbon dioxide
Reducing soil cultivation	carbon dioxide
Precision irrigation, such as drip or subsurface	nitrous oxide
Reducing irrigation	nitrous oxide
Deeper rooting grapevines	carbon dioxide
Reducing anaerobic soil conditions	nitrous oxide
Improving efficiency of nitrogen applications	nitrous oxide
Reducing off-site nitrogen movement (surface runoff/ erosion)	nitrous oxide

How I understand each of the practices in the table on the previous page to mitigate greenhouse gas emissions is explained with these simple categories: plants, soil, energy, fertilizer application, and waste.

Plants – Having plants in addition to the crop being farmed increases the amount of atmospheric carbon dioxide getting converted into oxygen, energy, and biomass.

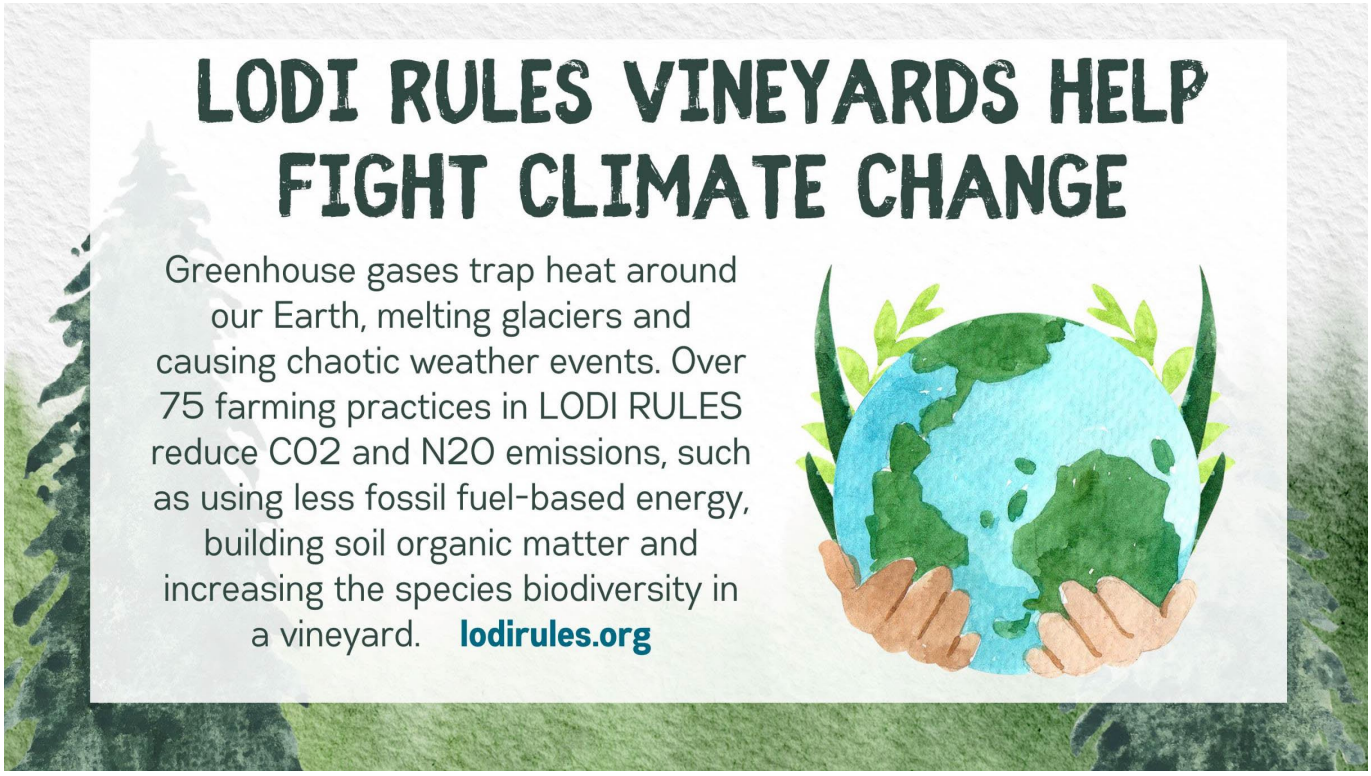
Soil – Organic matter stored in soil reduces the amount of carbon dioxide released to the atmosphere.

Energy – Reduction of the use of carbon-based fossil fuels for energy.

Fertilizer application – Minimizing nitrous oxide emissions.

Waste – Reducing the amount of waste decreases the need to create new raw materials and goods.

There is a lot of crossover, but I tried to highlight the main impact effect category above for each farming practice standard in the current Fourth Edition of LODI RULES. Refer to the LODI RULES binder, available from the Lodi Winegrape Commission or online at **lodigrowers.com/standards**, for more information about each farming practice.



LODI RULES CHAPTER 1: BUSINESS MANAGEMENT

LR 1.9. Fuel and electricity use are tracked (energy)

LR 1.10. The farming operation uses alternative forms of energy (energy)

LR 1.11. The farming operation increases efficiency of mechanical operations by treating more than one row at a time OR by combining two or more mechanical tasks in one pass (energy, waste)

LR 1.12. The importance of recycling is a part of employee orientation and training and the farming operation recycles metal, paper, cardboard, glass and plastic in designated containers (waste)

LR 1.17. The farming operation increases efficiency via automation. (energy, waste)

LR 1.18. Paper-free LODI RULES audit. (waste)

LR 1.19 Training on the carbon cycle (plants, soil)

LODI RULES CHAPTER 3: ECOSYSTEM MANAGEMENT

LR 3.4. A cover crop is maintained between at least every other vine row and tilling does not take place during the winter months (plants, soil, energy)

LR 3.5. The farming operation has woodlands (plants, soil)

LR 3.5.1 and 3.5.2. The farming operation has enhanced the buffer around woodlands with vegetation (plants, soil)

LR 3.6. There are individual, preserved trees under company control in or adjacent to the vineyard block on company property (plants, soil)

LR 3.6.1 and 3.6.2. Vegetation is planted and maintained or at least grows around individual, preserved trees (plants, soil)

LR 3.7.1. Low stature vegetation (hedgerows, shrubs, etc) is maintained around the vineyard block on company property (plants, soil)

LR 3.8. California native vegetation is maintained on headlands, roadsides, and around trees (plants, soil)

LR 3.9.1. Seasonal wetlands are preserved with a permanent vegetative buffer strip around the entire perimeter (plants, soil)

LR 3.10.1. Riparian habitat exists on company property (plants, soil)

LR 3.11.1 There is a vegetative buffer between vineyards and intermittent water bodies (plants, soil)

LR 3.14. The farming operation has a written and implemented livestock grazing management plan (energy, soil)

LODI RULES CHAPTER 4: SOIL MANAGEMENT

LR 4.1. The farming operation has a written and implemented nutrient management plan (soil, fertilizer application)

LR 4.2. The farming operation is aware of the erosion and compaction risks of the vineyard soils and has a written and implemented soil conservation plan (soil)

LR 4.3. Soils in the vineyard have been characterized (soil)

LR 4.4. Soil samples from the vineyard have been analyzed and the results incorporated into the nutrient management plan (soil, fertilizer application)

LR 4.5.1. Throughout the growing season, vegetative cover is maintained between every vine row and not tilled (plants, soil, energy)

LR 4.5.2. Every other row middle is tilled only as needed with the other row middles left undisturbed (plants, soil, energy)

LR 4.5.3. Row middles are only tilled as needed (plants, soil, energy)

LR 4.6. The pH is between 5.5 and 8.0 (soil, fertilizer application)

LR 4.7. Organic matter has been added to the vineyard soil using a cover crop, compost, or manure (soil, fertilizer application)

LR 4.9. Irrigation water was tested and soil amendment programs and nutrient management plans were altered according to the results (soil, fertilizer application)

LR 4.10. Soil samples from the vineyard were analyzed for macronutrients and micronutrients and the results are incorporated into the nutrient management plan (soil, fertilizer application)

LR 4.11. A petiole or leaf blade sample has been sent to a lab for analysis (fertilizer application)

LR 4.12.1a. Nitrogen is applied as a non-mined, biological source (fertilizer application)

LR 4.12.1d. Nitrogen will not be applied this year because adequate amounts are provided by a cover crop and/or irrigation water, and vine tissue analysis indicates that the vines contain adequate amounts of nitrogen (fertilizer application)

LR 4.12.2.1. Finished compost is used as a nitrogen source (waste, fertilizer application)

LR 4.12.2.2. Non-composted grape pomace, manure, and/or legume-rich green manure cover crop is used as a nitrogen source (fertilizer application)

LR 4.12.3.1. For each nitrogen source material, records of the fertility analysis report are kept (fertilizer application)

LR 4.12.3.2. Compost, pomace, or manure is incorporated after application and/or green manure cover crops are incorporated immediately after chopping (fertilizer application)

LR 4.12.3.3. The spreader is calibrated so that the application rate is known (fertilizer application)

LR 4.12.3.4. Compost, pomace, or manure is applied after harvest in the fall and/or in the spring before bud break (fertilizer application)

LR 4.12.4. The amount of applied manufactured or mined nitrogen is limited and never applied when the vine is dormant (fertilizer application)

LR 4.13.1. The vineyard is never cultivated under dry, windy conditions or a permanent cover is maintained (soil)

LR 4.13.2. A perennial or native vegetative cover is maintained on the vineyard headlands (plants, soil)

LR 4.13.3. A hedgerow on the upwind edge of the vineyard serves as a windbreak (plants, soil)

LR 4.14. Slopes are less than 10% or the vineyard follows a reputable erosion control plan (soil)

LR 4.14.1.1. Permanent vegetative cover is maintained between every row (plants, soil)

LR 4.14.1.2. Any sloped headlands have water erosion control (soil)

LR 4.14.1.3. Berms restrict water erosion (soil)

LR 4.14.1.4. A vegetative filter strip is maintained on the downslope edge (plants, soil)

LODI RULES CHAPTER 5: WATER MANAGEMENT

LR 5.1. The farming operation has a written and implemented water management plan (soil, energy)

LR 5.3. Irrigation water was tested for irrigation suitability and the results are incorporated into the water management plan (soil, waste, fertilizer application)

LR 5.5. The irrigation power plant is electric with renewable energy or the water is delivered by gravity flow without supplemental power (energy)

LR 5.5. The irrigation power plant uses electric equipped with a time of use plan from a utility district, propane, or diesel (Tier 2 or greater) (energy)

LR 5.7. Irrigation is performed using low volume – surface or low volume – subsurface systems (fertilizer application)

LR 5.7.1. In low volume – surface irrigation systems, filters, gauges, submains, drip lines, and emitters are checked, line leaks are repaired, and clogs are freed (fertilizer application, energy)

LR 5.7.2. In low volume – subsurface irrigation systems, flow meters, pressure gauges, and relief valves are checked and leaks are repaired (fertilizer application, energy)

LR 5.8. Pump efficiency has been measured within the last 5 years or the pump is less than 5 years old (energy)

LR 5.9. Irrigation system distribution uniformity has been tested and recorded or the system uses subsurface drip and relief valves are checked (energy, fertilizer application)

LR 5.11. Soil moisture content is known or soil moisture tension full point (field capacity) is known (soil, energy)

LR 5.12.1. Soil moisture depletion is determined by soil monitoring devices or the bucket auger/shovel method is used to assist in deciding when and how much to irrigate (soil, energy)

LR 5.12.2. Vine water status using a device or visual observations is used to assist in deciding when and how much to irrigate (soil, energy)

LR 5.12.3. Evapotranspiration determined by a local weather station or a nearby CIMIS station with similar climatic conditions is used to assist in deciding when and how much to irrigate (soil, energy)

LR 5.13.1 and 5.13.2. The amount of water used by the vines on a weekly basis is estimated and recorded and this amount or less is applied to the vines during the next week (unless a heat wave is forecasted or varietal requirements necessitate the use of more water) (soil, energy)

LR 5.14. Irrigation practices create no runoff or runoff is recycled (soil, waste, energy)

LODI RULES CHAPTER 6: PEST MANAGEMENT

LR 6.1 and 6.11. The farming operation has written and implemented insect/mite and powdery mildew management plans (energy, soil, waste)

LR 6.2, 6.20 and 6.28.1. The PCA and/or company representative monitors the vineyard for insect/mite pests and weeds, and keeps written monitoring records (energy, soil, waste)

LR 6.3 and 6.4. Treatments for leafhoppers and mites are only applied when the economic thresholds are reached (energy, soil, waste)

LR 6.5 and 6.28.3. When an insect or mite treatment is necessary, only that portion of the vineyard where a problem exists is treated, not the whole vineyard (energy, soil, waste)

LR 6.6. During the growing season, vegetative cover is maintained in at least every other vineyard row (plants, soil, energy)

LR 6.7. During the growing season, vegetative cover is maintained on vineyard roads and avenues (plants, soil, energy)

LR 6.8. A hedgerow and/or vegetative cover is grown on headlands (plants, soil, energy)

LR 6.12 and 6.13. A disease model such as the Gubler-Thomas powdery mildew model is referred to scheduling of powdery mildew fungicide applications (energy, soil, waste)

LR 6.14. For fungicides other than those with negligible risk of resistance development, resistance management is practiced by rotating fungicides and not using chemicals with the same mode of action consecutively (energy, soil, waste)

LR 6.17. The farming operation has a written and implemented soil borne pest management plan (soil)

LR 6.16 and 6.20. The farming operation has a written and implemented weed management plan which includes scouting (energy, soil, waste)

LR 6.23. Owl boxes, kestrel boxes, and/or raptor perches are provided and maintained (energy)

LR 6.24. The farming operation or the custom applicator has a written and implemented sprayer/duster maintenance plan (energy, soil, waste)

LR 6.25. The amount of spray/dust being applied per acre is monitored to ensure that the correct amount is being applied and this procedure includes immediate calibration if any correction is indicated (energy, soil, waste)

LR 6.29. The farming operation has a grapevine virus management plan (waste)

LODI RULES Pesticide Risk Model: PEAS 2.0

LR 6.33. Reduces the amount of pesticide applications (energy, soil, waste)