Virginia

Sustainable Viticulture Practices Workbook

September 2011

Preface

This document is one stage of a multi-step project to guide Virginia grape producers who wish to increase the sustainability of their vineyard operations. The project has been an industry initiative from the start, and will continue to have input from end-users such as you, and from an industry steering committee.

The document was distributed in draft form in August 2011 to members of the Virginia Vineyards Association. Based on feedback from that circulation, a revised scoring scheme and other, minor changes to the document were made. We would like to receive comments back on this version of the document prior to January 2012. Please use the workbook in assessing the sustainability of your own vineyard and let us know about your experience. What worked, what didn't, and what would you like to see that was not included here? For example, one or two people who reviewed the preliminary draft felt that environmental sustainability needed to be strengthened. We welcome these suggestions but would ask for specific suggestions on scientifically-sound methods for improved sustainability.

Your input will help determine the next steps of this initiative. Let us know what you would like to see in a future phase of this project. Let us know if you are interested in joining a core committee that will meet in January 2012 to move this project forward. All feedback will be organized and shared anonymously with the core committee in January 2012.

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Introduction

This workbook was conceived and developed by a committee that included industry representatives from Virginia vineyards and wineries, the Virginia Vineyards Association, as well as input from viticulture specialists at Virginia Tech and Virginia Cooperative Extension. The central goal was to provide both existing grape growers and potential growers with a roadmap towards a more sustainable vineyard enterprise. The reader and user should ask, What is sustainable? The workbook committee used the commonly accepted definition of a sustainable agricultural operation. It is one that strives for three goals or outcomes: minimizing environmental degradation, practicing social responsibility, and achieving vineyard profitability. Minimizing environmental impact can include avoiding soil erosion, preventing ground or surface water contamination by pesticides or other vineyard inputs, or by preventing harm to beneficial or other non-target organisms in the ecosystem. Social responsibility includes protecting the welfare of vineyard workers and consumers, and respecting the rights and property of neighbors as well as abiding by acceptable community standards. Profitability, at its simplest, is gross returns exceeding operating expenses. But profitability may also reflect improvements to the environment, health benefits of a physical, horticultural endeavor by owners/management, or other less tangible quality of life rewards.

Each of the 118 questions posed in this workbook was given substantial thought as to how it impacted sustainability and whether there was consensus as to what the desirable response was to achieve increased sustainability. A fundamental requisite for inclusion of a question was that there was good experience, science, or ideally both, to support including the element.

Although the workbook was designed for both beginning growers and experienced growers, most of the listed practices will apply more to established operations which are interested in a sustainability audit and, ultimately, improving the sustainability of their operation.

The workbook should help growers:

- Succeed in growing high quality fruit that is marketable
- Explain concepts important to sustainable wine grape production
- Assess current vineyard practices
- Identify components of vineyard operations where improvement will lead to increased sustainability

How to use this workbook:

1. Read though the workbook and pay attention to each section introduction and its why components.

2. Complete the workbook by addressing each of the posed questions. Be honest and fairly score each question by marking with a check mark which column most accurately describes your level of compliance for that particular vineyard practice or design decision.

3. The choices, in decreasing measure of compliance, are 100%, 75%, 50%, 25% and 0%. For example, if you felt that the particular question could be answered affirmatively, or without qualification, essentially all the time, then check the 100% column. If a response were true most of the time, check 75%. If it were true or false in roughly proportional measures, check 50%, and so on.

4. Review the responses:

    a. Characterize responses by subsection.

    b. Subsections that contain a high proportion 50% or lower compliance scores are areas to focus effort on for incorporating more sustainable practices in future years. We have not assigned acceptable or "passing" scores at this point. Your goal should be to improve your score every year.

    c. Identify items which can be implemented in the vineyard.

    d. Implement these changes or learn more from a grower already using this practice or from a Virginia Cooperative Extension agent or specialist.

5. Repeat this process annually. Vineyard practices can always be improved to increase ecological, social and economic sustainability. Compliance with the activities described in this workbook should help the operation move towards a more sustainable operation. Annual evaluation of compliance should also identify areas where improvements have been made – celebrate these improvements – you are on the way toward vineyard sustainability.

I. Pre-plant considerations: Site evaluation, vineyard design, rootstocks and scion, training system, soil analysis and pre-plant soil amendments:						
Vineyards in Virginia are challenged by biotic and abiotic threats. The selection of a suitable site, design of the vineyard to match the site and the goals of the operation are essential to the sustainability of the vineyard enterprise.						
		100%	75%	50%	25%	0%
1	Selected vineyard site, in part, for its relatively high elevation.					
Why? High elevation relative to surrounding terrain reduces the likelihood of frost and winter injury to the vines. Higher topography also enhances air movement that can aid disease management. Vineyard Site Selection Bulletin: http://pubs.ext.vt.edu/463/463-020/463-020.html						
2	Selected vineyard site, in part, on the basis of low to moderate soil fertility and good soil structure that demonstrates rapid internal soil water drainage and relatively low water-holding capacity.					
High fertility and high water-holding capacity soils tend to promote overly vigorous grapevines, which aggravates disease management, increases vineyard management costs and can reduce wine quality potential.						
3	Selected vineyard site, in part, due to its isolation from adjacent, abandoned vineyards or wooded areas that harbor wild grapevines.					
Abandoned vineyards or wooded areas serve as reservoirs for pests and pathogens of grapevines.						
4	If using a site which previously was farmed with grapes, removed any old, abandoned vines and/or vineyard blocks and allow a fallow period in those blocks for several years.					
Abandoned vineyards may still harbor diseases and pests for years after the removal of grapevines. Establishing a non-host crop such as cereal grains or perennial grass to grow for a three year period will deplete on-site grapevine pest populations.						
5	Selected site with adequate water sources.					
Available water sources may be needed to supply irrigation, spray water needs and other water needs.						
6	Purchased and planted certified vine stock.					
While certification does not guarantee freedom from pests and pathogens, it does generally ensure a healthier vine than what might be obtained from non-certified plant material.						

7	Rootstocks were selected for the scion variety, vineyard objectives and soil conditions.					
Rootstocks vary to some extent in the vigor and vine capacity conferred to the scion. Rootstocks may also provide some field resistance to certain nematode-transmitted viruses. **Factors to consider when selecting grapevine rootstocks:** http://www.extension.org/pages/31620/factors-to-consider-when-selecting-grapevine-rootstocks						
8	Designed vineyard and planted inter-row cover crops to minimize soil erosion during vineyard establishment and operation.					
Perennial, inter-row crops prevent soil erosion as well as reduce soil compaction, allow movement of machinery in the vineyard sooner after rains, and minimize perennial weeds.						
9	A buffer zone was established between the vineyard and wild grapevines.					
A 200-yard minimum buffer zone is recommended because wild grapevines can be a reservoir for grape pests and diseases such as grape berry moth and grape root borer.						
10	Constructed soil erosion barriers while installing the vineyard and road systems to prevent topsoil loss.					
Soil erosion barriers help to prevent surface water run-off and nutrient leaching and therefore lessen the loss of topsoil applied nutrients.						
11	Consulted with experienced wine growers, extension educators, or wine grape specialists for advice on vineyard site selection					
Vineyard site selection experts can give advice to prevent future problems and help select the best possible site for wine grape vineyard sustainability and quality potential. Site selection depends on many variables, including aspect, altitude, air flow/drainage, soil profile, nearby pest infestations and land use i.e. neighbors.						
12	Analyze soil for physical, structural and hydrologic properties of vineyard soils when designing vineyard.					
Soil properties will influence vine size and differences in soil properties will have large implications on vineyard variability.						
13	Analyze soil for nematode populations before installing the vineyard.					
Nematodes which are harmful to grapevines, and are easily managed before planting. Incorporating a rape seed cover crop will help eliminate nematodes without the need of chemical fumigants. Pre-plant Renovation and Soil Condition for new Vineyards (pg. 76) **Wine Grape Production Guide for Eastern North America**						

14	Completed a chemical soil analysis of each vineyard block before installing the vineyard.					
It is necessary to understand the pH and nutrient status of the soil so that lime and fertilizer can be applied correctly before the vineyard is established.						
15	Made appropriate soil amendments (and incorporate if necessary) before planting and trellis installation.					
It is easier and cheaper to make soil amendments if large trucks can access the field and apply lime and fertilizer in bulk. Incorporating these amendments is also more difficult and costly once the vineyard has been established. Some amendments, such as lime, are not very mobile in the soil and therefore should be applied well ahead of planting. Some amendments, such as Nitrogen, are very mobile and should only be applied during periods of active vine uptake. Pre-plant Renovation and Soil Condition for new Vineyards (pg. 76) **Wine Grape Production Guide for Eastern North America**						
16	Developed a state nutrient management plan for farm and applied nutrients as prescribed by that plan.					
Nutrient management plans are documents that make a site specific plan for efficient use of plant nutrients to best meet plant needs and minimize negative impacts on the environment. **Department of Conservation and Recreation:** http://www.dcr.virginia.gov/stormwater_management/nutmgt.shtml						
17	Determine the nutrient leaching/run-off potential for your soil/vineyard and applied appropriate nutrient application methods as necessary.					
Determine the nutrient leaching/run-off potential for your soil/vineyard and applied appropriate nutrient application methods as necessary.						
18	Grow varieties less susceptible to major diseases such as Powdery Mildew, Downy Mildew, Black Rot, Phomopsis and Botrytis where repeated applications of sprays would be needed to protect vines.					
Reducing chemical inputs will help protect the air, water and soil from potentially harmful pollutants, reduce costs and keep neighbors friendly.						
19	Use pest resistant rootstock when growing varieties susceptible to phylloxera, tomato and tobacco ring spot virus.					
These diseases have no remedial treatment and infected vines must be removed. Control of the vectors of these diseases can be difficult and costly in established vineyards.						

20	Installed fencing to keep out deer and small animals.					
Deer and other vertebrate pests can cause substantial damage to the grapes and browsing can severely delay vineyard establishment.						
21	Allowed sufficient headland area to grow windbreaks or hedgerows to help prevent spray drift, at least on leeward side of vineyard.					
Minimizing spray drift out of the vineyard helps protect the environment, reduces input costs and benefits vineyard-neighbor relations.						
22	Use generous buffer zones when applying pesticides near water, neighboring crops, private or public properties, schools, roadways and other sensitive locations.					
Contaminating waterways and allowing sprays to drift into public areas can lead to substantial fines and administrative costs, as well as damaging the environment and creating strife within the community.						
Section I Score: Sum the number of responses within each column. Sum of this row should total 22.						

II. Soil Management, Fertilization, and Irrigation:						
A grapevine requires carbon dioxide, sunlight, water and 16 essential nutrients for normal growth and development. Sustainable nutrient management in vineyards must incorporate understanding of the natural processes of soil biology and plant physiology with the grower's production goals. Soil is a medium to anchor grapevines and provides reserves of water and nutrients. Irrigation can be used to supply water to grapevines when rainfall is insufficient to meet grapevine water needs.						
		100%	75%	50%	25%	0%
1	Monitor the nutrient status of the vineyard every year.					
Why? Three means to assess the nutrient status of the vineyard are: visual symptoms, soil tests, and petiole analysis. Visual symptoms of nutrient levels in the plant can show up in leaf markings, leaf color and vine growth. Soil tests will reveal the soil pH and quantify nutrient availability. Plant tissue analysis of leaf petioles shows the concentrations of nutrients within the plant tissue; this indicates what the vine is actually taking up. Combining the information from these three indices will characterize the vineyard nutrition.						

2	Apply nitrogen fertilizer during periods of grapevine root development to maximize uptake. In the case of large quantities (> 30 lbs. of actual N per acre), split the application into two applications, such as at approximately bloom-time and then 4 to 6 weeks later.					
Matching nitrogen (N) fertilizer application to periods of active uptake of N by the grapevine (post bloom -> leaf senescence) ensures that the vine take up N fertilizer; and reduces possibility of N fertilizer leaching out the vine's root zone. Splitting the application of nitrogen extends the absorption of N across the most efficient phase of plant nutrient uptake.						
3	Fertilizer application is based on calibrated spreader or other methodology that ensures the appropriate amount is applied uniformly.					
Nutrients are expensive and essential to grapevine growth; therefore the miss-application of nutrients will lead to undesirable vine growth, unnecessary extra cost and environmental contamination.						
4	Add organic matter to soil to improve structure, drainage, fertility, and water-holding capacity, if necessary.					
The addition of organic matter, such as composted leaf litter, trimmings or pomace; can improve both the structure and chemical properties of some vineyard soils. In general, soil organic material provides most of the grapevines required Nitrogen; and over time organic material improves soil water internal drainage, soil moisture capacity and soils resistance to compaction and erosion. Keep in mind, high organic material coupled with deep, fine textured soils with high water holding capacity will lead to excessive vine vegetative growth.						
5	Record all nutrient addition amendments.					
These records will be useful for accounting purposes, to gauge the efficacy of fertilizer applications and for future management decisions.						
6	Know the nutrient leaching/surface run-off potential for your soil/vineyard and correct nutrient application methods as necessary.					
Know your vineyard soils. This knowledge will be invaluable for vineyard design and management as well as preventing environmental contamination. Well drained sandy soils have high leaching potential relative to fine textured soils.						
Section II Score: Sum the number of responses within each column. Sum of this row should total 6.						

III. Vine training and crop/canopy management						
It is critical that grapevines have a large area of healthy leaves exposed to sunlight. Train vines to promote canopy densities which provide excellent: light penetration, air circulation, and spray coverage. Good canopy management is the foundation of disease management, assures the potential to achieve optimal fruit composition and assures good crop potential in the following growing season.						
		100%	75%	50%	25%	0%
1	Quantify vine size though pruning weights and match crop level.					
Why? Balancing vine size and crop level are essential to vine health, vineyard longevity and grape quality. Crop load is easily calculated as vine yield/cane pruning weight. A crop load value below 5 indicates an under-cropped vine which could easily produce and ripen more fruit without compromising vine health or grape quality. A crop load value above 10 is possibly over-cropped, which can compromise vine health and grape quality. A good review of the underlying principles of canopy management is the canopy management chapter of the **Wine Grape Production Guide for Eastern North America** (http://www.nraes.org/nra_winegrapecontent.html).						
2	Conduct an annual survey and regularly scout to assess vineyard conditions and identify potential problems; e.g., prevalence of leafroll viruses, drought-prone sections of the vineyard, fungal disease/insect problems etc.					
Scouting and knowledge of specific vineyard blocks is an essential component of sustainable vineyard management.						
3	If you have varieties susceptible to bunch rot fruit zone leaf pulling should be practiced to thin the canopy to no more than one leaf layer in the fruit zone.					
Exposing the fruit will reduce the pressure of bunch rots. Leaf pulling is not recommended if the fruit clusters are already well exposed (e.g. if > 80% are visible from the side of the canopy). Leaf pulling can increase risk of sunburn and undesirably heat the fruit in some cases.						

4	Use canopy management as the foundation of an effective disease management program. Train vines to a desirable canopy density (one or two leaf layers) through the vineyard.					
Desirable canopy density (less than two leaf layers) will promote: efficient leaf function, air circulation, and spray coverage. Efficient leaf function is required for production of carbohydrates needed for fruit production and maturation. Air circulation is necessary in a humid environment; air circulation reduces the moist conditions that favor disease development. Spray coverage is needed because effective use of agricultural chemicals requires that sprays are evenly deposited on the target - congested canopies do not allow for even deposition of agricultural chemicals on grapevine canopies.						
Section III Score: Sum the number of responses within each column. Sum of this row should total 4.						

IV. Groundcover and weed management in established vineyards						
Groundcover management techniques can reduce soil erosion/compaction, nutrient runoff, and herbicide use. Groundcover management strategies will influence soil organic matter, vine vigor, erosion, vineyard nutrition, herbicide use and vineyard water status. The strategy for groundcover management will depend on characteristics of the site and goals of the vineyard operation.						
		100%	75%	50%	25%	0%
1	Maintain perennial, inter-row cover crops to minimize soil erosion, reduce soil compaction, allow machinery movement sooner after rains, and to minimize establishment of perennial weeds in the vineyard.					
Why? Perennial cover crops between the vine rows protect and maintain topsoil- and are a common recommendation for Virginia vineyards.						
2	Conduct seasonal weed surveys and know what weeds are present in your vineyard. Use this information to choose herbicides and application rates, or use non-herbicidal management strategies for weeds.					
Different weeds each pose unique threats to the vineyard and may require different management techniques						
3	Under-trellis cover crops are managed with a strategy of increasing, decreasing, or maintaining vine capacity, as needed.					
Under-trellis cover crops can suppress grapevine growth. A wider weed-free strip may be needed in non-irrigated vineyards or to increase vine size and trellis fill. In established plantings, reducing the width of the weed-free strip can be used to intentionally suppress excess vegetative growth of grapevines. Under-trellis cover crops are associated with decreased use of herbicide/cultivation, minimizing erosion potential, and improved soil structure.						

4	Keep written records of weed location and the identity of hard-to-manage weeds, as well as species that have escaped annual weed management programs.					
Record keeping is an important component of sustainable vineyard management. Control aggressive perennials with spot treatments. Periodically monitor weed size, vigor, and species composition to optimize weed management strategies.						
5	Establish cover crops to help control nematodes, when possible.					
Planting and maintaining plants that are not good hosts (e.g. perennial grasses) for nematodes is a good means to lower nematode pest pressure.						
Section IV Score: Sum the number of responses within each column. Sum of this row should total 5.						

V. Pest management						
The goal of this section is to review the sustainability of our pest and disease management program. Grape disease management will be one of the major key components for a sustainable viticulture in Virginia because our environments are conducive to many fungal and other diseases that can cause significant economic damages if they are not well managed. Chemical control measures are often discussed, but it is important not to rely on chemical management options alone. Overuse and/or misuse of chemicals will not only cost you more money, but also it can result in negative consequences to the environment. Thus, the combination of management tactics or Integrated Pest Management (IPM) strategies is the fundamental for a sustainable grape disease and pest management.						
		100%	75%	50%	25%	0%
1	Consider not only the ecology (population of pests and other organisms) but also the economy of your pest management practices.					
Why? It is very important to be sustainable in both ecological and economic sense. Proper planning of pest and disease management strategies prior to the season is a key aspect of a cost-effective and environmentally sound program. The social aspect will be covered in the "Pesticide Safety and Efficacy" section.						
2	Use only pesticides registered in your state and approved for use on the target pest, disease, and crop. Consult the most current Pest Management Guides for Virginia (see the links in the "Recommended Information" section at the end of this document).					
Pesticide regulations change frequently. Please read and follow the label, which is the legal documentation.						

3	Consider hiring a vineyard consultant if time does not permit you to complete the tasks that are listed in this section.					
Vineyard management is time-consuming. Consider hiring a qualified consultant if you do not have the time to effectively manage the day-to-day details of the vineyard.						
Section V Score: Sum the number of responses within each column. Sum of this row should total 3.						
A. Disease management						
1	Be able to recognize and identify wine grape diseases (see the links in the "Recommended Information" section at the end of this document).					
It is critical for you to recognize major grape diseases in VA. Without proper identification of diseases, it is not possible to establish effective management strategies or communicate with extension agents and other growers.						
2	Be able to recognize and identify the environmental (weather) factors that favor disease development (see the links in the "Recommended Information" section at the end of this document).					
Disease development depends heavily on the environmental conditions (especially temperature, precipitation, relative humidity, and the vine's growth stage). Be sure to understand pathogen biology so management strategies to effectively disrupt their life cycle.						
3	Utilize cultural practices (e.g., canopy management) and cultivar selection as primary pest control practices and use agricultural chemicals to supplement control of pests.					
Humid growing conditions favor disease development. Thus, you will need to combine all available means of control in order to have a sustainable program (i.e., use Integrated Pest Management). The cultural practice and cultivar selection is the first step of the disease management. If possible, select and plant varieties that are less susceptible to major diseases such as powdery mildew, downy mildew, black rot, phomopsis, and botrytis.						
4	Obtain certified grapevines from reputable sources.					
Planting certified plant material minimizes the risk of graft-transmitted diseases such as leafroll virus, Petri's disease, etc.						
5	Select excellent vineyard sites for better disease management.					
The environmental conditions are the key factors for disease development; thus, well air-drained sunny vineyards tend to have less disease risk than do shaded vineyards. Moreover, cold damage can increase the chance of Botryosphaeria and crown gall infection.						

6	Remove wild grapevines within 200 yards of your vineyards and from nearby habitats, if possible.					
Wild grapes can be hosts for many pathogens and pests, including grapevine yellows.						
7	Understand that some own-rooted hybrids are susceptible to soil-borne diseases such as tomato and tobacco ringspot virus.					
These viruses may reside in alternative hosts and they can be transmitted by nematodes. Grafting hybrid grape varieties on a resistant rootstock can lower the risk of transmission.						
8	Remove infected plant tissues from the vineyard.					
Many plant pathogens can survive within infected tissues to cause disease in following season(s). For example, both black rot and ripe rot pathogens can survive in infected mummies over winter and cause disease in the following year.						
9	Pruned canes are finely chopped and left in the vineyard row middles to recycle organic matter, or they are removed and buried.					
Pruned canes can harbor many pathogens, including phomopsis, botryosphaeria, black rot, etc. Finely chopping the wood hastens decomposition. Burial is more sustainable in that the carbon is sequestered in the soil rather than liberated immediately as CO and CO_2 by burning.						
10	Develop access to weather data for your vineyard.					
In order to accurately assess the risk of diseases, you need to have an access to weather data. You can either find a local weather station nearby your vineyard (often times you can access to it via internet sites), or install weather equipment to your vineyard.						
11	Use disease development and forecast models to help manage diseases, especially powdery mildew, downy mildew, black rot, and Botrytis.					
You can estimate risks of disease development from environmental conditions. The information is available through various sources, including “VA Grape Disease Updates” (a link is listed at the end of this document). In addition, there are fungicides that have kick-back or curative properties (i.e., you can apply it after infection took place). Utilizing these tactics can reduce the number of fungicide application.						
12	Scouting on foot should be conducted at least weekly by the same person, if possible, and more often during periods of high disease pressure.					
Even with a good management program, you still need to examine your vines on foot. Your sprayer might have missed a row of vines due to various reasons. The observations should be recorded and maintained for a future reference.						

13	Keep written records of monitoring efforts including sampling dates, locations, damage levels, etc., in order to establish disease history of your vineyard.					
Knowing the disease history of a particular block can help your decision-making in the current and future seasons. You may have a hot spot where a particular disease always shows up at the beginning of the season (e.g., Powdery mildew tend to show up first on susceptible varieties that are shaded for a portion of the day). Map the location of these disease "hot spots" and use as regular scouting "checkpoints".						
14	At harvest time, record incidence of disease on fruit and fruit quality for different blocks in order to assess efficacy of management.					
This will not only help to estimate potential wine quality, but also to optimize future disease management protocols. High disease incidence will serve as a warning for more strident practices needed for future disease control.						
15	Use the recommendations in the Virginia **Pest Management Guides** and other documents written by wine grape specialists when monitoring and managing diseases.					
There are several guidelines for disease and pest management that are tailored for VA wine grape growing conditions. Most of them are freely available (Links to these resources are listed at the end of this document), and updated each year.						
16	Read and follow the pesticide label, which is the legal documentation which details how the pesticide can be applied.					
The aforementioned guidelines can be a good resource, but the regulation changes very frequently. When in doubt, follow the label.						
17	Select fungicides based on the target pathogen and host.					
Efficacy of many modern fungicides is specific to a certain group of fungi, but not to others. For example, many fungicides for powdery mildew are not effective against downy mildew. Plus, you need to use the fungicides that are registered for application to grapes.						
18	Develop a disease management strategy or template, including approximate spray frequency and material choice, well before the growing season starts.					
It will help you to estimate the number of fungicide applications, to assess cost associated with the fungicide program, and to plan purchase of materials. You will need to adjust your schedule based on field conditions, but the template will save you time and money because it will ensure that fungicides are on hand when needed and valuable time won't be lost attempting to obtain materials at critical times of the growing season.						

19	Know that the timing of fungicide application depends not only on the presence of the target disease, but also the grape's physiological stages.					
For example, the critical time for powdery mildew, downy mildew, and black rot infection on berries are from bloom to 4-5 weeks after bloom. After that period, berries become resistant to infection. Please refer to the Virginia Pest Management Guide for detailed information.						
20	Understand that there is a risk of fungicide resistance with many of the modern fungicides.					
Many modern fungicides target specific functions of a pathogen at cellular or genomic function level, thus, there will be always the risk of the development of fungicide resistant isolate. Many new fungicides available for grape have a history of developing resistant isolates to different crops or pathogens.						
21	Understand that the risk of fungicide resistance will increase based on the history of fungicide applications in your vineyard(s).					
Fungi can develop resistance to a particular fungicide mode of action; this resistance is developed more rapidly if fungicides with the same mode of action are used multiple times. In order to prolong the life of fungicide, rotate the mode of action and keep good record of your chemical applications. Be aware that different products may not necessarily have different modes of action (i.e., Fungicide Resistance Action Committee code). If the mode of action is the same, it is practically the same material.						
22	Be cognizant that beneficial predatory mites can be protected by using EBDC fungicides (e.g., mancozeb) prior to bloom ONLY, or not at all.					
There is a risk of reducing beneficial predatory mite population by using EBDC fungicides throughout the season. If you have mite problem, you may want to consider alternatives.						
Section V-A Score: Sum the number of responses within each column. Sum of this row should total 22.						
B. Arthropod Management						
1	Be able to recognize and identify grape arthropod (insects and mites) pests and the injury or damage that they cause (see the links in the "Recommended Information" section at the end of this document).					
Chief arthropod pests are certain insects and mites. Correct identification is essential to implement targeted management strategies.						
2	Prune or remove pests by hand, if possible.					
Cultural management is the first step for the arthropod management. Consider the use of insecticide as a supplement to cultural practices.						

3	Follow monitoring protocols and pest management techniques recommended by reputable, established sources such as Virginia Cooperative Extension's **Pest Management Guide**.					
There are several guidelines for disease and pest management that are tailored for VA wine grape growing conditions. Most of them are freely available (Links to these resources are listed at the end of this document), and updated each year.						
4	Regularly (a weekly basis by the same person) monitor pest (arthropods, weeds, vertebrates) populations and disease prevalence using visual assessments, sticky traps, pheromones, etc. Keep written records of monitoring efforts, sampling dates, damage levels, trap catch numbers, injury thresholds used, etc.					
Knowing the level of infestation is critical to manage some insect pests. For example, pheromone traps, degree-day models, and risk assessment protocols can be used to make informed management decisions for grape berry moth and grape leafhopper. However, for some pests (e.g., grape root borer), monitoring may not necessarily be very effective at predicting population levels.						
5	Use mating disruption as a control option, where available.					
In order to minimize the potential negative effect of insecticide application on beneficial insects. Use mating disruption, which targets activity of a specific pest, is a valuable tool. **Mating disruption:** http://www.virginiafruit.ento.vt.edu/PtdUsage2.html						
6	Time pesticide application to least impact beneficial arthropods and to help prevent secondary pest problems.					
Pest populations are very dynamic and one action to control one pest, can affect the target population and other pests and beneficial organisms.						
7	Understand how to time pesticide applications in order to avoid impacting honeybees and native pollinators (i.e., spray in the very early morning, evening, or at night).					
Although grapes are self-pollinating, bees are present in vineyards.						
8	Conserve naturally occurring biological control organisms (e.g., parasitic wasps, mites, flies, etc.) by using selective, NOT broad-spectrum, pesticides. Participate in bio control release programs, and conserve habitat for beneficial insects, if possible.					
Beneficial insects may offer control of vineyard pests.						

9	Use only pesticides registered in your state and approved for use on the target pest and crop. Consult the most current Pest Management Guides for Virginia (see the link in the "Recommended Information" section at the end of this document).					
The regulation changes very frequently. Please read and follow the label, which is the legal documentation.						
10	At harvest time, sample fruit from different blocks in order to assess and record damage levels.					
As with disease management, keeping records will help to optimize future pest management protocols.						
11	Utilize spot or perimeter applications of insecticides when feasible.					
Some pests tend to aggregate and the risk of spread is low. There is no need for applying pesticide all over the field, if you can manage by treating only infested vines. Many arthropod pests originate outside the vineyard and the vineyard "edges" are the first zones of infestation – when possible, control these pests by applying pest control materials to the edge of the vineyard.						
12	Be aware that some arthropod and disease issues are very closely related.					
For example, leafhoppers and sharpshooters transmit grapevine yellows and Pierce's Disease, respectively. Wounds from grape berry moth can be entry points for diseases such as Botrytis and sour rot.						
Section V-B Score: Sum the number of responses within each column. Sum of this row should total 12.						
C. Vertebrate management						
1	Install fencing to keep out deer and small animals.					
Once they are in the vineyard, these animals can compromise your yield very quickly. Various styles of fencings are available (electric, mesh, etc.). Investigate on the options that suit your situation. Some people utilize dogs. When you do, please make sure to protect your dogs from rabies.						
2	Use repellents, baits, physical barriers, traps, and other deterrents to repel and/or control vertebrate pests. Combining practices increases success.					
These methods will help control pest populations in and around the vineyard. Also be aware of the local populations of animal and bird pests. There may be different pests causing damage during different times of the season. You may also have a certain species that can be more of a threat than others.						
3	Moles, rabbits, and ground hogs are more problematic where vegetation is heavy enough to offer cover, so practice good ground cover management.					
Reducing conditions conducive to pest habitats will help control pest populations in and around the vineyard. When your vines are young, grow tubes can be used to prevent rabbits and other chewing animal damage.						

4	Trap or hunt vertebrates (where legal) making sure to follow all local regulations.					
Trapping or hunting vertebrate pests will help control pest populations in and around the vineyard. Make sure these activities are legal and allowable in your community. If you are close to a residential area, you may wish to discuss management options with your neighbors.						
5	Protect and enhance natural predator (e.g., owls, foxes, hawks) populations by providing attractive habitats for them.					
Natural predators to vertebrate pests will help control pest populations in and around the vineyard. You may also consider creating a habitat for territorial bird such as wrens.						
6	Reduce bird damage with noise (e.g., bangers), visual tactics (e.g., scare eyes), or exclusion methods (e.g., netting).					
Bird damage to fruit can increase the incidence of rots and represent a loss of crop. Observe your local bird populations closely. Different bird species can exhibits different behaviors. Some are migratory population, which may appear only a certain time of the year.						
Section V-C Score: Sum the number of responses within each column. Sum of this row should total 6.						

VI. Pesticide safety and management

Secure storage, safe mixing and handling of pesticides are necessary for personal, environmental and community well-being. This section covers the basic requirements and procedures involved in pesticide use. Pesticides are an important component of sustainable vineyard management; however careless storage and use can pose significant risks. Simple precautions described here can reduce those risks and help ensure that pesticide users comply with state and federal law and protect themselves, their workers, and their environment.

Although the intent of this workbook is to encourage sustainability, it is important to emphasize that certain aspects of pesticide handling and application are not voluntary; they are mandated by state and federal law and articulated on pesticide labels and in state and federal law. Worker Protection Standards (WPS), for example, describe the legal requirements of employers to provide personal protective equipment, signage to protect workers and the public from entering pesticide-treated areas, and decontamination materials in the event of spills and exposure.

	A. Pesticide storage	100%	75%	50%	25%	0%
1	Pesticide storage is separated from other farm operations in a locked area or separate building and posted with appropriate, pesticide storage signage.					
Why? Separation of pesticides from other activities minimizes the likelihood of contamination from inadvertent spills or exposure. Keeping the storage area locked prevents unauthorized entry of potentially unprotected workers or family members and minimizes the potential for theft and other potential unlawful activity.						
2	If stored over winter, pesticide storage area is heated to avoid freezing temperatures.					
Freezing can alter the physical properties of certain pesticides, potentially rendering them ineffective or possibly unstable when mixed with other pesticides. Freezing can also rupture the storage container resulting in leakage.						
3	Pesticide storage uses appropriate containment and non-porous shelving and flooring with the flooring designed to contain spills if they occur.					
Wood, particularly composite construction, absorbs spills and is difficult to effectively remove hazardous materials that have penetrated the surface. A contained flooring system, such as epoxy-treated concrete, permits containment and recovery of spilled pesticides.						
4	Pesticides are stored in original, labeled containers and/or opened packages are placed within clear plastic containers with lids to prevent exposure to moisture. Liquid containers can be set in over-sized aluminum or plastic trays on shelves to contain drips and possible leaks.					
The pesticide label specifies certain labeling and storage requirements. Placing containers within oven roasting pans or similar plastic storage trays provides back-up containment for spills and potential package rupture.						
5	Pesticides are used completely within the year they were purchased. Multiple-year storage is minimized and unused products are disposed of through approved county or state pesticide disposal programs.					
Pesticides that are stored in cool (40 – 100°F), dry conditions normally retain efficacy for 2 or more years; however, it is prudent to minimize the long-term storage of product for several reasons including loss of product registration, potential expiration, and to reduce the total amount of pesticide stored on-farm.						
6	An inventory of pesticides, including product name, amount and removal usage record is updated monthly and maintained on-site in a secure location.					
The list can be used to replace inventory before items are exhausted, to remove older products, and to provide information to emergency personnel in the event of a fire or other damage to the storage facility.						

7	Pesticides are purchased from a reputable dealer using only products that are specifically labeled for use on the site (e.g., grapevines).					
Again, the label has explicit, legal obligations, including the allowed sites for application of a particular pesticide. Purchasing from a reputable dealer who specializes in distribution of agricultural chemicals minimizes the potential for unscrupulous salesmanship or the sale of defective or ineffective product.						
Section VI-A Score: Sum the number of responses within each column. Sum of this row should total 7.						
B. Pesticide mixing and handling						
1	Pesticides are mixed and loaded in sprayers at least 100 feet away from surface water, waterways, and water wells.					
The spatial separation of water source and mixing/loading operations helps minimize the potential for surface water and well water contamination.						
2	Sprayer filling systems are equipped with appropriate anti-backflow devices, such as in-line devices or a clear separation of the filling pipe and the sprayer filling port.					
The anti-backflow device is designed in this case to prevent the backflow of pesticide laden water back into the well. Ideally, the sprayer loading area should be equipped with an elevated water tank with sufficient capacity to meet the spraying needs of the entire vineyard or a day's spraying. Such a tank allows for rapid refill of the sprayer, but also eliminates the potential for accidental back-flow from the spray tank if there is a clear separation of the discharge pipe and the sprayer filling port. Approved anti-backflow devices must be used if sprayers are filled from hoses plumbed directly to well.						
3	Pesticide handling, mixing and rinsing area is situated where a pesticide spill, leak or overflow could not get into water system. A concave, impermeable surface which could contain the largest amount of spill or leak likely to be created at the site is an effective means of protecting local water systems from pesticide released as a spill during mixing. Equipping with a system for recovering and removing spilled material into an evaporation shed or to be recycled for spraying are also desirable features.					
Pesticides that are delivered anywhere other than the target can cause environmental contamination, possible danger to people nearby and represent an economic loss.						

4	Pesticide handling area is equipped with a spill kit that includes: Personal protective equipment (PPE), phone number for emergency assistance, appropriate respirator, containment “snakes”, sweeping compound for containing dry materials, heavy duty detergent, and a fire extinguisher rated for all types of fire, absorbent materials, garbage bags, dust-pan and broom/shovel. Items are stored in a vessel with lid which can be used to collect spilled materials for disposal.					
A spill kit allows pesticide users to quickly respond to spills and possibly keep a small spill from turning into a large problem. Check pesticide label for instructions for cleaning up a spill. Sweeping-up spilled dry chemicals is preferred to vacuuming which can further disperse finely milled powders that escape the vacuum filters. If reasonably clean, recovered pesticides can either be salvaged for crop use, or stored in closed, plastic containers for appropriate disposal.						
5	Personal Protective Equipment is not stored in pesticide storage or handling area.					
Clean and store PPE in a secure location removed from pesticides to avoid contamination of the PPE by spills or vapor.						
6	Worker Protection Standards compliance information, including emergency contact telephone numbers, is posted in areas frequented by workers.					
Employers have a legal obligation to inform pesticide handlers and agricultural workers about risk, to provide protective equipment and remedial options such as eye-wash kits in the event of exposure, and to post telephone contact information in the event of emergencies. The posting of this information must be in a central area frequented by the workers. **VDACS**: http://www.vdacs.virginia.gov/pesticides/wps.shtml						
7	Pesticide mixing and handling is performed or under direct supervision of a certified private or commercial pesticide applicator.					
Pesticide application certification is required by federal and state law for restricted use pesticides and is an excellent option even if only purchasing and using general use pesticides. Use of restricted pesticides requires the “direct supervision” of a certified pesticide applicator – in this case, certified applicator is responsible for actions of uncertified applicator.						
8	Mixed pesticides are used in entirety on the target crop, minimizing the amount of residual material in the sprayer.					
Proper sprayer calibration and equipment operation reduce the chance of having large amounts of spray material left over at the completion of a spray application. This is turn reduces the need for disposal of spray material.						
9	Sprayer rinsate is applied to labeled crop or retained in an approved evaporator facility that prevents leaching into soil and groundwater					
Start the cleaning of a sprayer by adding 5 gallons of clean water to the tank and spraying this on the vineyard. This will dilute any residual spray material in the tank, reducing the accumulation of concentrated pesticides in the sprayer cleaning area.						

10	Pesticide labeling is explicitly followed, including use of appropriate PPE and recording of application details for the duration required for the category of pesticide used.					
The pesticide labeling will specify minimum PPE requirements and record-keeping is a legal requirement with certain pesticides and an excellent idea with all pesticides.						
Section VI-B Score: Sum the number of responses within each column. Sum of this row should total 10.						
C. Pesticide application technology						
1	Monitor weather conditions to allow proper drying time and to avoid drift due to windy conditions. Spray only when wind, temperature, and humidity conditions are suitable for applying chemicals unless the sprayer is modified to reduce drift (e.g., hooded boom, deflectors, low drift nozzles, shielded applicator).					
Agricultural chemicals that are not deposited on their intended target are an economic loss, environmental contaminant, and will not function in their intended role.						
2	Maintain accurate and complete pesticide application records. Record pesticide applications, including date, time, weather, operator, sprayer details (e.g., nozzle specifications, pressure, forward speed, application rate), field identification, targeted pest, pesticide name and EPA number, formulation, re-entry interval (REI), pre-harvest interval (PHI), and number of acres treated.					
Records of pesticide applications are mandatory for restricted use materials, and a good practice for accounting and evaluation of management practices.						
3	Equipment is inspected and properly calibrated at least once a year, or more often as necessary. Be sure all workers whose responsibilities include pesticide application know how to and troubleshoot sprayer equipment. Clean equipment after each use, or between applications of different products.					
Properly calibrated equipment is necessary for accurate deposition of agricultural chemicals on intended targets. Failure to clean equipment between uses allows for potential corrosion and contamination of equipment.						
4	Discuss with a local Extension agent your legal obligations as they pertain to pesticide usage. Become a certified applicator and maintain certification.					
A) Certification increases your knowledge of proper application technique. B) Certification is required to purchase restricted-use chemicals.						

5	Utilize drift-reducing sprayers or sprayers that have been modified (i.e. towers, deflectors, angled fans, air induction nozzles) to direct the chemicals to discrete portions of the canopy (e.g., only the fruit zone).					
Agricultural chemicals that are not deposited on their intended target are an economic loss, environmental contaminant, and will not function in their intended role.						
6	Select nozzles that optimize droplet size and avoid those that produce fine droplets (<150 microns). Nozzles must point toward the target canopy.					
Droplets of less than 150 microns increase the chance of drift to non-target areas.						
7	Grow windbreaks or hedgerows to minimize spray drift out of the vineyard. Use generous buffer zones when applying pesticides near water, neighboring crops, private and public properties, schools, roadways, and other sensitive locations.					
Buffer zones decrease the amount of drift that reaches non target areas and promotes good neighbor relations. Incorporating wildflowers into buffer zones can increase beneficial insect populations.						
8	Implement a Worker Protection Standards (WPS) compliance program.					
It's the law. A list of WPS requirements and many compliance materials are available from the EPA (www.epa.gov)						
9	Correctly identify and regularly monitor pest populations or disease pressure BEFORE attempting chemical controls.					
A) Monitor forecasted weather conditions and adjust spray application timing accordingly to avoid unnecessary sprays. B) Careful monitoring of pest populations and resulting damage determines when economic thresholds have been reached.						
10	When pesticides are to be utilized, choose a chemical based on efficacy, reasonable cost, and safety to applicators, native pollinators, natural enemies and the environment.					
A) Use of chemicals that target a specific pest reduces negative effects on beneficial populations. B) Rotate chemical class to avoid resistance.						
11	Clearly post Restricted Entry Interval (REI) information and confirm that workers, handlers and visitors understand how to determine if/when a vineyard is safe to enter. Use this information as a guide for restricting others from entering treated areas.					
REI information should be posted in a designated common meeting area for all vineyard workers. Use approved signage to inform workers and guests about restrictions for each vineyard block. Remove signs when the REI has expired.						

12	Monitor weather conditions to allow proper drying time and to avoid drift due to windy conditions. Spray only when wind, temperature, and humidity conditions are suitable for applying chemicals unless the sprayer is modified to reduce drift (e.g., hooded boom, deflectors, low drift nozzles, shielded applicator).					
Spraying in adverse conditions reduces efficacy, increases cost, and increases drift to non-target areas.						
13	Maintain accurate and complete pesticide application records.					
A) Maintaining accurate spray records of restricted use materials is the law. The use of a spray log such as those provided by the EPA is recommended. Spray records must be available to anyone who asks to see them. B) Detailed spray records are an important reference tool.						
Section VI-C Score: Sum the number of responses within each column. Sum of this row should total 13.						

VII. Grower/employee education						
Training employees/growers about environmental implications of vineyard management decisions is key to achieving a reduced environmental impact. Job creation and professional development of employees enhances the local community and contributes to social equity. Two problems that cause considerable conflict between agriculture operations and neighbors/local communities are a lack of communication and the profusion of misinformation.						
		100%	75%	50%	25%	0%
1	Attend local and regional grower meetings each year.					
Why? Grower meetings promote a strong community within the industry and provide an opportunity to exchange knowledge and expertise.						
2	Join local grower association(s) and cultivate relationships with Cooperative Extension personnel.					
Grower associations and Cooperative Extension provide growers with a wider range of resources and continuing education.						
3	Obtain current fact sheets and guides for wine grape production from your local grower association, Extension specialists, or Extension agents. Vineyard workers should be strongly encouraged to read these.					
A better educated work force increases the likelihood of recognizing potential vineyard problems, reduces mistakes, and empowers workers to make better decisions. Reference materials from a trusted source such as the **Wine Grape Production Guide for Eastern North America** are invaluable tools for developing vineyard management strategies.						

4	Participate in local Extension workshops, demonstration plots, and/or short courses on wine grape production, pest identification, and pest management options. Encourage vineyard workers to attend.					
Staying current with vineyard management options and strategies greatly reduces unnecessary chemical inputs to the vineyard.						
5	Regularly attend Pesticide Applicator training offered by Extension and other agencies.					
Certification training keeps the pesticide applicator current on new technologies, techniques, and local regulations concerning pesticide use. Proper training also reduces the risk of accidents from improper pesticide handling or application.						
6	Read online newsletters produced by your local Extension specialists or other unbiased sources.					
Online resources often have the most recently updated information. Only use information from a reputable source.						
7	Implement IPM practices not currently used in your wine grape pest management program on a limited number of vines and gauge their success.					
Small scale experiments are a good way to test new vineyard management practices without a large expenditure of time and resources.						
8	Learn and understand your obligations as an employer under the Worker Protection Standards (WPS), Hazard Communications Standard (HCS), and other labor regulations (i.e., OSHA, etc.).					
Following legal labor requirements increases safety for all workers and promotes good employer/employee relations.						
Section VII Score: Sum the number of responses within each column. Sum of this row should total 8.						

References and resources

- Virginia Tech, Viticulture Resources, http://www.arec.vaes.vt.edu/alson-h-smith/grapes/viticulture/extension/index.html
- Crop Profile for Grapes in Virginia, http://www.ipmcenters.org/CropProfiles/docs/vagrapes.pdf
- Wine Grape Production Guide for Eastern North America, http://www.nraes.org/nra_order.taf?_function=detail&pr_id=178&_UserReference=6C90D6B0B9A9FCD949A2C568
- The Mid-Atlantic Wine Grape Grower's Guide, http://www.ces.ncsu.edu/resources/winegrape/
- Fungicide Resistance Action Committee, http://www.frac.info/frac/index.htm
- Laws and Regulations Affecting Pesticide Use in Virginia, http://vtpp.ext.vt.edu/pesticide-safety-education-program/laws-and-regulations-affecting-pesticide-use-in-virginia
- Pesticide Handling and Storage Practices on the Farm, http://www.epa.gov/opp00001/regulating/storage.htm
- The Southern Region Small Fruit Consortium Small Fruit Regional Production Guide http://www.smallfruits.org/SmallFruitsRegGuide/
- Virginia Vineyards Association, http://www.virginiavineyardsassociation.com/
- Virginia Tech's Site for Grape IPM & Production, http://www.virginiafruit.ento.vt.edu/VirginiaGrapeSite.html
- Virginia Tech Mid-Atlantic Vineyards Grape IPM, http://www.virginiafruit.ento.vt.edu/grape-fruit-ipm.html
- Virginia 2011 Pest Management Guide for Commercial Vineyards (Virginia Coop. Ext. Pub. 456-017), http://pubs.ext.vt.edu/456/456-017/Section-3_Grapes-2.pdf
- Virginia Grape Disease Update, http://grapepathology.blogspot.com/
- Viticulture Notes: http://www.arec.vaes.vt.edu/alson-h-smith/grapes/viticulture/extension/VN_options_index.html
- Virginia Department of Agriculture and Consumer Services (VDACS): Office of Pesticide Services http://www.vdacs.virginia.gov/pesticides/
- Worker Protection Standards, http://www.epa.gov/oecaagct/twor.html
- Virginia Green – Wineries Program : Virginia DEQ http://www.deq.state.va.us/p2/virginiagreen/wineries.html