# Sustainable Blackberries & Raspberries

## A Self-Assessment Workbook for Growers


U of A DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Center for Agricultural and Rural Sustainability

SOUTHERN SARE
Sustainable Agriculture Research & Education

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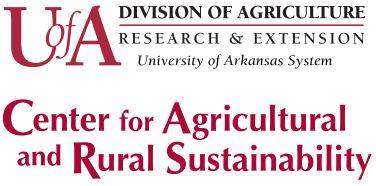




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# Contents

A fall crop of Prime-Ark® 45 blackberry grown inside a high tunnel for season extension. Photo by Luke Freeman.

# Introduction

Sustainability, from an agricultural production and management standpoint, has several useful definitions. One of these is, "Sustainable production meets the needs of today's operation without compromising the future of the operation." In other words, a farmer should produce crops in a way that optimizes resource use, optimizes production, and provides sufficient economic returns to provide for the grower and his employees, while contributing to the community and maintaining the operation so that it continues as a viable farm in the future, with long-lasting economic returns and satisfaction.

Legally and technically, "Sustainable Agriculture" has been defined in the U.S. Code (U.S. Code Title 7, Section 3103) as

> *an integrated system of plant and animal production practices having a site-specific application that will, over the long-term:*
>
> - *Satisfy human food and fiber needs.*
> - *Enhance environmental quality and the natural resource base upon which the agriculture economy depends.*
> - *Make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.*
> - *Sustain the economic viability of farm operations.*
> - *Enhance the quality of life for farmers and society as a whole.*

This definition is a key component of the legislation and development of the USDA National Institute of Food and Agriculture (NIFA), and Sustainable Agriculture Research and Education (SARE) programs. The research and education sponsored by NIFA and SARE must meet these definitions and it is these definitions that drive a sustainable agriculture future for the U.S.

As growers, we can combine and condense these definitions into a more workable framework. Commonly, sustainability is viewed as having three primary components that should be considered: profit, planet and people. Sustainability is generally viewed as a three-legged stool, with all three components considered equally in the overall decision-making process. It is useful for farm managers to consider each of these three components of sustainability individually and then consider them as an integrated whole.

## Profit

Without profit, a farm is not a business and will cease to exist. It is important that the farm operation be economically viable. Profits at a level that provide for the needs of the producer, for his or her employees, and to maintain the operation are important. Profit is often viewed only as a seasonal or annual bottom line. However, from a sustainability standpoint, profitability must be considered not only in the short term but in the long term.

This is easy to understand in fruit production. For instance, if a fruit planting is overcropped one year in an effort to maximize production, it might lead to a smaller crop the next year, and economic failure. Similarly, a grower may try to increase profitability by not providing adequate nutrition for the crop, or by shutting off irrigation after the harvest season. Again, those management decisions might not manifest as problems until the following year. Therefore, it is important to manage the system for both the present year and the coming year. Especially in perennial fruit crop production, problems can pile up. Ignoring a problem in any year in an effort to improve profits will only become a bigger problem in future years and will reduce future profits.

As a producer, one cannot control all of the aspects of profitability, especially market forces. So the focus should be placed on making sustainable management decisions that positively impact profitability in the current and all subsequent years. A grower and farm manager should focus on what he or she can control: capital, resources, and management.

Thus, the goal of a sustainable fruit operation is to optimize long-term profitability by having an

acceptable profit in the current year so that one can plan on an acceptable profit in each year to come, and by increasing the value of the fruit production operation into the future, building equity from the investment of capital, resources, and management, and staying in business for the long term.

## Planet

Without good land, there would be no farm. To produce a crop, the farm needs the planet's resources. Three key environmental elements are the soil, water, and the air. The farm also needs energy sources to operate equipment and for the chemicals that are used in operations. A fundamental basis of crop management is managing these elements to produce an economic crop. It should be self-evident that if the soil or water resources used to sustain the crop deteriorate, the crop will eventually fail. Sustainable production is a production system that sustains and/or improves the soil and water resources and wisely uses other resources, such as energy, so that the cropping system will continue into the future.

Practices that damage or destroy the soil will result in poor plant growth and cropping. Practices such as overcultivation, excessive use of fertilizers, excessive use of agricultural chemicals (herbicides, insecticides, fungicides and bactericides), lack of pH maintenance, and loss of soil organic matter all result in soil destruction. As the soil deteriorates, both surface and ground water will deteriorate, as well. With damaged soils, nutrients can become imbalanced and enter either surface or ground water. Applied agricultural chemicals will not break down naturally in the soil and will enter the water system. The soil will not hold water for plant use. Therefore, plants will experience swings from flood to drought and the water itself may be toxic to the crop, as well as to animals and people who also rely on the water resources. Damaged soils are more prone to soil erosion, resulting in less soil for the cropping plants and increased water pollution. The soil is a virtually irreplaceable resource.

A goal of sustainable farming is to manage the system purposefully to sustain or improve the soil and water in the farming system. With damaged soils, more equipment management and more agricultural chemicals are needed to optimize growth and cropping, and thereby profitability may drop. With more equipment use and more chemical use, there is greater environmental pollution of air and water. Coupled with declining soil organic matter and poorer crop growth, more greenhouse gases are released, contributing to the potential for impacts on climate change. Impending climate change threatens to greatly reduce the opportunities to successfully farm in the future, with more variable weather, periodic disastrous storms, more frequent flooding, droughts, wind, hail and seasonal temperature variation.

Agricultural chemicals have significant economic and environmental impacts. Some chemicals are less expensive than others to use. The efficacy and duration of efficacy of chemicals can vary. Some chemicals are "softer" and others "harder" on the environment. The environment includes beneficial insects, animals and fish in the farming system, soils, and the people applying the chemicals or consuming the products. Some chemicals are harsh pollutants and have long persistence in the environment. The most common problems associated with unsustainable chemical use are using the wrong chemical, or applying it at the wrong time, or applying it in the wrong way, or applying it at the wrong rate, so that it is either ineffective

Josephine raspberry at the Arkansas Agricultural Research and Extension Center in Fayetteville. Photo by Luke Freeman.

and wasted, or becomes toxic or a pollutant in the system. A principle of sustainable farming is to make purposeful management decisions about judicious use of agricultural chemicals and alternatives, so as to have the best economic impact, with optimized horticultural impact, and the least environmental impact.

## People

Without farmers and farm workers there would be no farm. It is important that those involved in the production system are fairly compensated economically, are safe and healthy from their work in the farm, find satisfaction in the work, and as a result will continue in the farming system. It is important that farmers find value in what they do and contribute to the local, regional and national economies, and that they contribute in meaningful and appropriate ways to their communities. Farmers should be important and valuable assets to the community.

Agriculture occasionally suffers a bad reputation in our communities because of mismanagement, leading to negative reputations and feelings. Farms should be managed so that the surrounding communities find value in both the products and the people who are on the farm. As with any company, short-term profiteering can lead to poor business relations. Those operations that farm without regard to environmental resources and the communities surrounding them, and that clearly result in destruction of soil and water resources, develop bad public personas. Conversely, farms that become part of a community acquire social value and equity.

When social value and equity are lost, regulations and laws are typically made to limit the negative impacts or to drive out farming; people in the community view the farm as detracting from their quality of life. However, when farms develop social value and equity, and become an important cultural and social part of a community, the opposite tends to happen: laws and regulations are often created to support urban or local agriculture and to protect farmland because of its value to the community.

The goal of a sustainable farm is to create value around the enterprise and its people so that the farm can be maintained and people will want to farm in the future.

Student intern Olivia Caillouet harvests Natchez blackberries. Photo by Luke Freeman.

## Triple Bottom Line: Profit, Planet, and People

It is clear to see and understand that profit, planet and people are interrelated. And that becomes another key aspect of sustainability — interrelatedness and connectedness. It is often said about understanding sustainability that "everything is connected to everything else." This requires a different mindset and operational framework from how farming has often been viewed and practiced. Individual operations on the farm cannot be thought of and practiced in isolation. Every decision should consider how an operation affects other operations and aspects of the farm: how do decisions affect the farm this year and in future years? Decisions on profitability may have profound positive or negative impacts on the soil, water and air, and on the people working and living on the farm and consuming the farm products. Decisions about soil, water and chemical management have profound effects on the profitability of the farm, this year and in the future. Those decisions can affect global climate, can affect the people who work on the farm, and impact the community of the farm. If the farm and farmers are valued, the enterprise and products produced will be valued, affecting farm profitability. Indeed, on the farm, everything is connected to everything else. No decision can be made in isolation.

The decision-making process for a sustainable enterprise, therefore, often uses the notion of the "triple bottom line:" farmers must think about how their decision(s) affects profitability, the planet and

its environmental resources, and people, including farmers, consumers and the community.

Sustainability is a process more than a goal. The objective of sustainable agriculture is to have a vibrant, economically valuable farm system providing wholesome and nutritious foods while sustaining and contributing positively to environmental resources and contributing to the value of the community. Is sustainability ever achieved? Yes and no.

It is actually easiest to understand a non-sustainable farm. That is a farm that goes out of business due to poor productivity, lack of profitability, and loss of economic value. The land is depleted so it has no agricultural value. The farm is not valued in the community. The farm goes out of business and no one else wants to participate in farming. So, non-sustainability is easy to achieve. Loss of sustainability can happen quickly.

Sustainability is a process of continual decision-making and effort to become more sustainable, creating a farm enterprise that will exist year-to-year and will continue to exist in the future. Characteristics of a sustainable farm include: a farm that considers annual and future profits and has a business plan for future success; a farm that treats the environment with the knowledge that the farm needs good soils, water and air in the future; a farm that makes management decisions understanding the limitations of resources and the impact of management practices; a farm that understands its effects on climate and resources and its role in protecting the planet; and a farm that strives to improve annually and seeks to have increased equity and value so that it can continue indefinitely into the future.

Primocane blackberries and raspberries are grown in a high tunnel for fall season extension. Photo by Luke Freeman.

Sustainability is a process, a continuum. The goal is to move through the process and along the continuum, so as to have the farm become more sustainable year after year.

Are there compromises in sustainable farming? Yes, of course there are compromises. The compromises in management decisions need to be made with the understanding of the interconnectedness of all operations on the farm.

The goal of this handbook is to help farmers understand individual tasks and decisions on the farm and to self-evaluate and rate the sustainability of those decisions. This book is not intended for use as a "one time" operation. It should be used annually with the idea of improving the farm. By using the checklist, growers can see where they are doing well, satisfactorily or need improvement. The goal is to move more checks from the "needs improvement" to the "satisfactory" category each year, and to move more checks from the "satisfactory" to the "excellent" category.

This workbook is meant as a guide for sustainable decision-making. It is not a set of recommendations but a set of considerations. Successful use of this book would be for a grower to start thinking more holistically about the farm operation: thinking about the triple bottom line of the farm.

We want your feedback. This workbook is based upon literature, evidence, and our experiences and knowledge, but it does not cover the complete set of management decisions a berry farmer might make. We hope that you will use the book, and, as it is being used, think of how, from your experiences and your knowledge of farm operations, we could improve the workbook. Think about what could be revised and what could be added. We would value your thoughts, comments and evaluations about how to improve this workbook and make it more valuable to growers to help them become more sustainable in their production.

Our research and outreach team wish you well in your operation and enterprise. It is our goal for you to become more sustainable. Thank you for using this material. It is our hope you find it instructive and insightful.

# Site Selection 1

## Introduction

The first step in establishing a blackberry or raspberry planting is choosing a suitable site. There are several considerations when selecting a site, including soil type, air movement, water drainage, sun exposure, cropping history, water availability, and slope.

Although blackberries and raspberries have similar requirements in regard to site selection, there are some key differences. Blackberries grow best in warm, temperate regions and are less winter hardy than raspberries. They are recommended for areas where winter temperatures stay above 10°F. Raspberries grow best where the season is long and summers are mild, with winters uniformly cool and long enough to satisfy chilling requirements. Most of the southern U.S. is not ideal for raspberries, although high elevations in the Appalachian Mountains provide ideal conditions, with moderate summer temperatures and consistently cold winters.

## Soil Type

Both blackberries and raspberries prefer well-drained soils that are relatively high in organic matter (2 to 4%). Soils with poor drainage encourage root rot diseases like *Phytophthora*. An ideal soil is naturally fertile, has the ability to retain moisture, and has a slightly acidic pH of 6.0 to 6.5. A soil with adequate fertility contains 50 to 100 pounds of phosphorus per acre, 250 to 300 pounds of potassium per acre, and 150 to 200 pounds of magnesium per acre. Sandy loams or loam soils are preferable to clay soils, although blackberries are better able to tolerate clay soils than raspberries.

## Air Movement

Blackberries and raspberries can be susceptible to spring frost damage at bloom time. Choosing a site on a slope or a level elevated area allows cold air to drain away on cool nights in spring and fall. A gentle slope of 2 to 3% is adequate for air drainage. A southern-facing slope offers the advantage of earlier ripening fruit, but there is an increased risk of winter injury. Warm winter temperatures or an early spring can stimulate bud break before the danger of killing frosts has passed.

Blackberries planted on the contour on sloped ground at the Fruit Research Station in Clarksville, Arkansas. Photo by Luke Freeman.

Low-lying areas or sites surrounded by trees should be avoided because they impede air movement. In addition to avoiding frost, proper air movement minimizes disease by allowing humid air to drain away in the summer. Humid conditions favor the development of diseases like anthracnose (*Colletotrichum* spp.). Exposed sites with strong winds should be avoided. In winter, strong wind can cause winter injury and cane breakage. Hot summer winds tend to desiccate both canes and fruit, increasing water needs and lowering fruit quality. If the selected site has strong winds, a windbreak of evergreen trees is beneficial, but the windbreak should be kept slightly open to allow adequate air movement.

## Cropping History

Because blackberries and raspberries are susceptible to numerous types of viruses, it is important to consider the previous cropping history of a site. Areas

Dicky Farms make use of sloped ground in Tontitown, Arkansas. Photo by Luke Freeman.

near other virus hosts or areas with a cropping history of virus hosts, such as tomatoes, tobacco, or other brambles, should not be chosen for blackberries. If plants such as tomatoes, potatoes, eggplant, peppers, tobacco, strawberries, or other bramble crops were planted at the site in the previous five years, the site should be avoided because it may be inoculated with the fungal pathogen verticillium wilt (*Verticillium* spp.). Certain broadleaf weeds, such as lambsquarters, red-root pigweed, and members of the nightshade family, can also increase chance of verticillium wilt. Crown gall infection is a possibility if the site was previously planted with infected blackberry plants. Wild brambles should be at least 350 feet away from the new planting to avoid the spread of diseases, especially viruses. If a site has been in sod for several years, white grubs and wireworms can be serious pests.

## Water Availability

Blackberry plants are able to survive periods of drought, but they will be unproductive. An adequate supply of irrigation quality water should be available at reasonable cost for the selected site to be successful for blackberries or raspberries. The proximity of the water source will determine the installation cost, plus future pumping costs. In some areas it may be necessary to check the legal issues associated with the use of high quantities of water for irrigation.

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Les Dozier at Sta-n-Step berry farm in Tontitown, Arkansas. Photo by Luke Freeman.

# Site Preparation 2

## Site Clearing

Site preparation should begin one to two years before blackberries or raspberries are planted. The first step is to clear the site of all woody plants, stumps, large roots, and wild blackberries. Because wild blackberries can harbor viruses, care should be taken to thoroughly kill and remove all residue from wild blackberries within at least 350 feet of the planting site. Perennial weeds such as Bermudagrass and Johnsongrass should also be eliminated from the site prior to planting. Management of perennial weeds will prove to be a difficulty if they are not dealt with before berries have been planted. Perennial weeds have the potential to aggressively compete with cultivated blackberries and raspberries for nutrients, moisture and sunlight and to severely limit berry health and yield. Sustainable weed elimination can be accomplished through multiple years of cover cropping, solarization, or biofumigation. Conventional methods that have a greater environmental impact include herbicide use, chemical fumigation, or frequent and timely tillage.

## Nematode Testing

The soil should be tested for nematodes and control measures taken if pest nematodes are present. Pest nematodes such as the dagger nematode (*Xiphinema* spp.) can harbor viruses and transmit them to bramble crops. Nematodes can be sustainably controlled through cover cropping with biofumigant mustards,


Sta-n-Step berry farm uses a perennial ground cover for row middles. Photo by Luke Freeman.

solarization or fallow. A conventional method of nematode control is chemical fumigation, which is very effective but has negative environmental consequences.

## Soil Testing

Soil samples should be collected and submitted to a soil-testing lab as soon as possible to determine soil characteristics and soil nutrient status. It is advised to submit soil samples through your county extension office. Soil cores collected should be 12 inches deep and comprise a representative sample of the field, with 15 to 20 samples per field. Further reading on collecting a soil sample can be found in the References section below. The soil should be amended according to the soil test result before berries are planted. Lime, phosphorus, potassium, calcium and magnesium should be applied six to 12 months before planting if they are required. The desired pH range is 6.0 to 6.5, and adequate levels of available phosphorus are 25 to 40 pounds per acre. Pre-plant potassium fertilizer should be applied, but the application rate will depend on soil test results. Brambles should not be fertilized with nitrogen until after planting, at which time 30-40 pounds per acre is sufficient. See resources below for more detailed fertilization recommendations.

## Subsoiling

The soil should be assessed to determine if subsoiling would be beneficial. If the soil is tight, impervious to water penetration, or contains a hard pan, then subsoiling can assist with water infiltration and root growth. It is recommended to subsoil in the fall, before the field is plowed or tilled. The shanks of the subsoiler should reach a depth of 18 to 36 inches and passes should be made twice through the field at 90-degree angles to crisscross the field. It is important that the field is not too wet during subsoiling, or further damage can be done through compaction. If subsoiling does not improve field drainage, then drainage tile should be priced and considered.

## Organic Matter

Soil should be amended with organic matter during site preparation, in order to increase the soil organic matter content, improve soil structure, and increase

Weeds are controlled with cultivation before a ground cover is seeded during blackberry establishment. Photo by Luke Freeman.

Cover crops such as crimson clover and cereal rye can be grown for soil improvement before berry planting. Photo by Luke Freeman.

water-holding capacity. Animal manures, green manures and composts are all good sources of organic matter. In total, 10 to 20 tons of organic matter per acre should be spread over the site and incorporated six to 18 months before planting. Animal manures and compost provide substantial amounts of phosphorus and potassium, in addition to micronutrients. Nitrogen can be added through manure or compost application, but it will likely not be in sufficient quantities to provide for the full needs of the bramble crop. If large amounts of manure or compost will be applied it is important to test the materials for soluble salts (EC should be less than 4) to ensure that excess soluble salts are not being added. Uncomposted manure should be applied at least 120 days before berry harvest to avoid food safety risk. Sewage sludge or biosolids containing human waste are not recommended as they may contain toxic levels of heavy metals or human pathogens.

## Cover Crops

Cover crops can provide multiple benefits during site preparation by suppressing weeds and soil-borne pests and contributing organic matter. Grass cover crops like sorghum sudangrass are able to contribute long-term organic matter, while legume cover crops like crimson clover contribute nitrogen and encourage a more rapid decomposition of the cover crop residue once it is incorporated. If pest nematodes are present at the site, a biofumigant mustard cover crop (such as oilseed radish or brown mustard) can be grown to suppress nematode populations before planting. The mowing and incorporation of the mustard cover crop produces glucosinolates which are toxic to nematodes. Grass cover crop species do not harbor pests that afflict blackberries or raspberries, which makes them well-suited cover crops to precede the planting of bramble fruits. Sorghum-Sudangrass is a well-suited summer cover crop due to its rapid growth and drought tolerance. Appropriate winter grass cover crops include oats, annual ryegrass, winter rye and winter wheat. At least three weeks should be allowed after the incorporation of a cover crop before the berries are planted. Additional nitrogen added before cover crop incorporation can assist in the breakdown of the cover crop residue, especially in the case of high-carbon residues.

## Ground Cover Establishment

After the soil has been properly amended with nutrients and organic matter, a perennial ground cover should be established to maintain the row middles

Mark Cain at Dripping Springs Garden uses a rotary spader for primary tillage. Photo by Heather Friedrich.

of the bramble planting. A well-maintained ground cover can prevent erosion, improve water infiltration, and ensure access to the field during rain events. Field access is especially important if this will be a Pick-Your-Own or U-Pick operation. Fescue and perennial ryegrass are recommended ground cover species. Best establishment will occur if the ground cover is seeded in the fall, with the soil amended to the proper pH (6.0 to 6.5) and sufficient nitrogen present in the soil (20 to 40 pounds per acre). Fescue should be allowed to grow at least five inches before mowing, with only one inch removed during each mowing. Fescue is especially sensitive to mowing and can be killed by over-mowing. Blackberry or raspberry rows should be established north-to-south to minimize sunscald and maximize fruit quality on both sides of the row.

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# Soil and Nutrient Management 3

## Soil Type

Blackberries and raspberries will grow in a variety of soil types, from sandy soils to heavy clay loams, but the ideal soil is a deep sandy loam that is high in organic matter (2 to 4%). Raspberries are less tolerant of heavier soils and prefer a sandy loam. Proper water drainage is crucial for both, however. Blackberries and raspberries do not grow well in situations where roots are submerged in standing water. In wet sites plants become unproductive and there is an increased susceptibility to root diseases. If a site is prone to temporary flooding, raised beds can be constructed to improve drainage. A raised bed should be 6 to 16 inches high depending on the severity of drainage problems, 3 to 4 feet wide at the top, and 4 to 6 feet wide at the base. Raised beds will dry out sooner than flat land during dry periods, so adjust irrigation accordingly. Typically, an elevated site with good air drainage has good water drainage as well.

## Soil Fertility

A healthy bramble planting will produce higher yields, be more competitive for water and nutrients, and more resistant to some insect pests and diseases. One way to ensure the health of plants is to make sure their nutritional needs are met. Growers should take leaf samples every summer and soil samples every fall. The cost of foliar analysis and soil sampling is well worth the savings in fertilizer costs and the profits from improved yields. More information on how to collect soil samples can be found in the References section below.

A soil test should be performed at least one year before planting to allow time to adjust the pH to the appropriate range (6.0 to 6.5) and to add nutrients that are lacking. Annual soil and foliar testing can provide valuable information, such as nutrient deficiencies and pH imbalances. All fertilizer and soil amendment applications in an established planting should be based on foliar and soil analysis results. This will eliminate problems with nutrient imbalances and save on fertilizer costs. For foliar analysis, 50 to 100 mature leaflets taken from primocanes between the sixth to 10th nodes from the terminal should be collected in mid-to-late July. Detailed information on when and how to collect leaves for foliar analysis, in addition to nutrient sufficiency ranges, can be found in the publication "Foliar Sampling for Fruit Crops" listed in the References section below.

Nutrient availability in the soil is dependent on pH, soil type, moisture content, nutrient mobility and nutrient concentration. If the soil pH is not in the

Soil samples should be collected and analyzed every fall to know the soil nutrient content and pH. Photo by Luke Freeman.

A soil probe can be used to collect multiple six-inch soil cores, which are mixed together to generate a sample. Photo by Luke Freeman.

appropriate range, certain nutrients are unavailable to the plant. Most nutrients are available between pH 6.0 and 7.0. Iron, boron, copper, manganese and zinc are unavailable in soils with a high pH. Calcium, potassium, magnesium and molybdenum deficiencies, as well as aluminum, manganese and iron toxicity, are common in acidic soil (low pH). Depending on the type of fertilizers used, heavy nitrogen fertilization can lower the pH of a soil over time, making it more acidic. In that situation, a liming agent (calcium carbonate, for example) would need to be added to bring the pH back into the desired range.

Certain soil types with a high cation exchange capacity (CEC), have a greater ability to hold and supply nutrients that have a positive charge (including potassium, calcium and magnesium). Soils high in clay and organic matter have a high CEC, while sandy soils have a low CEC. Due to the lower CEC, higher fertilization rates are needed in sandy soils. Many nutrients rely on water to move them toward and into the roots so adequate soil moisture is critical for uptake.

The interaction among elements is also important. For example, high levels of phosphorus can lead to zinc deficiencies, so use caution when using poultry litter or other fertilizers that are high in phosphorus. In addition, the repeated application of calcitic lime over time can lead to a high calcium to magnesium (Ca:Mg) ratio, inhibiting magnesium uptake. In such circumstances, dolomitic lime can be applied to add magnesium and bring the Ca:Mg ratio back to the proper range, between 2:1 and 8:1.

## Nutrient Management

### • *Nitrogen*

Nitrogen is one of the most important elements for the growth of most plants. Nitrogen has a dynamic cycle in the soil and is usually present at low levels compared to the crop's needs. Even though brambles do not require as much nitrogen as other crops, nitrogen should be the focus of any fertilization program. Floricane-fruiting blackberries and red raspberries require about 25 pounds of nitrogen pounds per acre in the first year of the planting, about 40 pounds per acre in the second year, and about 50 pounds per acre in the third and all subsequent years.

### • *Manures and Other Organic Materials for Nitrogen*

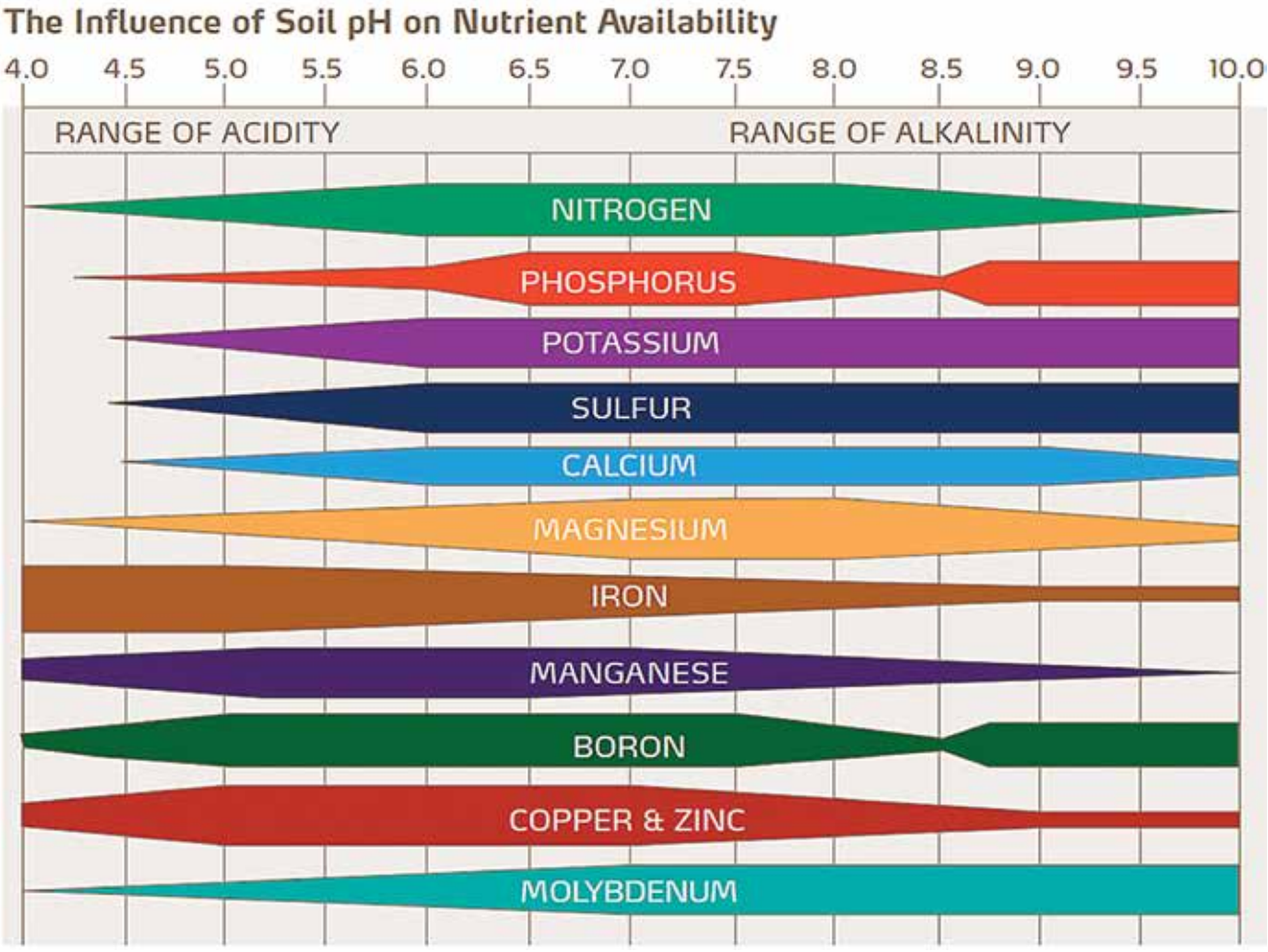
Manures and composts are good sources of nitrogen and organic matter, but have varying concentrations

of nitrogen, phosphorus and potassium. Because of the inconsistent nutrient content, an accurate recommendation rate is difficult to make. Only half of the nitrogen in manure or compost will be available to the plant in the year it is applied. The remaining nitrogen will be released in subsequent years. This holdover will need to be accounted for when figuring fertilization rates. Ideally, manure should be applied during late fall or winter to allow time for adequate decomposition. Fresh manure cannot be applied within 120 days of harvest due to food safety issues. Fully composted manure can be applied at any time and at higher rates than uncomposted manure. Another advantage of using composted manure is that the high-temperature composting process kills many of the weed seeds present in fresh manure.

Cottonseed meal (7-2-2) is a predictable source of organic nitrogen that is easy to spread within a row. Blood meal is a more expensive alternative, but it has higher nitrogen levels (12-1.3-0.7) that are readily available to the plants. In order to apply approximately 60 pounds of nitrogen, 860 pounds of cottonseed meal or 500 pounds of blood meal need to be used per acre. Feather meal (10% nitrogen) can also be used as an organic nitrogen source. If the aisle cover crop is contributing nitrogen to the soil, this should be taken into consideration before applying supplemental nitrogen.

- ***The Other Nutrients***

All nutrients other than nitrogen should be added only as needed. For example, monitor the phosphorus




Nutrient availability as affected by soil pH; the wider the band, the greater the availability. Image from Yara International. Adapted from Truog; USDA Yearbook of Agriculture 1943-1947.

content of the soil and the leaves. If the soil phosphorus is getting too high due to use of a fertilizer like chicken litter that contains phosphorus, begin to use an alternative fertilizer with no or low phosphorus, such as ammonium nitrate or cottonseed meal. If the foliar phosphorus content is too low, then an organic fertilizer that contains phosphorus may be a better option. Potassium is very important for berry size, quality and nutritional value. However, many soils can supply enough potassium for the plant. If leaf potassium content is lower than 1.5% then a potassium fertilizer should be applied.

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# Plant Selection 4

## Cultivar Selection and Plant Quality

One of the most important decisions to make before planting blackberries or raspberries is the cultivar and the plant source. Important characteristics of cultivars include chilling requirements, yield, disease resistance, bloom date, harvest dates and fruit shelf life. Once you choose which cultivars you want to grow, it is important to buy plant material from a trusted source. Be aware that patented cultivars cannot be legally propagated for sale or individual use unless there is a propagation agreement with the entity holding the patent.

If possible, purchase pants that have been derived from tissue culture and were virus tested. This will ensure that your plants are disease free. Starting with infected plant material can shorten the life of the planting by two to three years. Blackberry and raspberry plants are much less expensive than most other perennial crop plants, and plant cost is a minimal part of establishment costs. It is certainly not profitable to save a few pennies per plant at the cost of two to three years of yields.

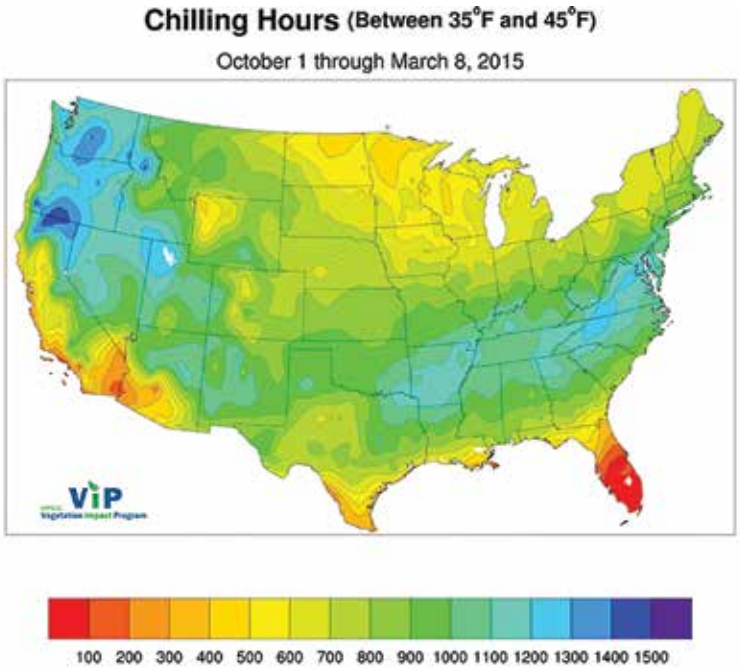
Primocane-fruiting (PF) blackberry cultivars are relatively recent developments. There are several possible advantages to producing blackberries with PF types. Overwintering diseases and pests, such as anthracnose and red-necked cane borer, can be avoided by mowing canes to the ground after the fall harvest. Also, production outside the traditional June-July harvest season can bring higher prices.

Fruit from primocane blackberry varieties are susceptable to fall frost damage. Photo by Luke Freeman.

Currently all of the PF cultivars are from the University of Arkansas. Most are thorny, and all have erect growth habit. Prime-Ark® Freedom, released in 2013, is the only thornless PF blackberry cultivar that is commercially available at this time. Of the four PF cultivars available, Prime-Ark® 45 is the one most recommended for growers on a trial basis. PF blackberries will fruit in the fall until a frost forces them into dormancy, and will begin fruiting again as soon as the weather warms in the spring. They do not have a chilling requirement. However, they grow with more vigor when they have experienced a minimum of 200 chilling hours. All four PF cultivars are resistant to double blossom and orange rust.

Buds from floricane blackberries damaged by a late spring frost (on left) compared to buds that were undamaged (on right). Photo by Luke Freeman.

It is important to obtain blackberry and raspberry plants grown from tissue culture and screened for viruses. Photo by Ioannis Tzanetakis.




## Chilling Requirements

The importance of a cultivar's chilling requirements depends on your location. In northern Arkansas, for example, chilling hours average above 1,200 each year so any cultivar can be grown. At the southern edge of the state chilling hours average below 1,200, and may be less than 900 some years. If a plant does not receive enough chilling, some flower buds will fail to break dormancy, and yields will be low and spread out. Thus, cultivars with lower chilling requirements are preferable in areas of the Deep South.

In recent years, advective freezes, which are brought by the movement of cool fronts, have plagued the Southeast at springtime. Cultivar selection can mitigate the negative effects of some freeze events. The further developed an inflorescence is, the more susceptible it is to freeze damage. Cultivars which have longer chilling requirements will be more likely to break dormancy later, and those with later bloom dates will be less advanced in the case of a freeze. This benefit comes with costs, however. Later bloom dates usually mean later harvest, which may impact the sale price or demand for the harvest.

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# Water Management and Irrigation 5

## Introduction

Fruit and cane development depend on an adequate supply of water. During the growing season, blackberries and raspberries need one inch of water every seven to 10 days. Spring and summer rainfall cannot be relied upon to provide for all water needs, which makes irrigation an essential component of bramble fruit production.

Inadequate water will result in poor fruit development, lower yields and smaller fruit, in addition to fewer primocanes and decreased cane diameter. Because drought reduces primocane growth, the effects of insufficient water carry over into next year's floricane crop. An adequate water supply is especially vital during the first growing season to aid in cane establishment and for subsequent harvests. Since water is one of the major abiotic factors affecting a crop's yield, efficient irrigation management practices are crucial to a producer's economic bottom line. The water source is also an important economic consideration. The cost of city or rural water utilities is usually too high for a commercial berry operation, so access to a water well or clean surface water is vital. Water source and water access will vary depending on location, but it is important to secure access to a high-quality water source that is economical. Irrigation water that contains a high mineral content or particulate matter should be filtered to avoid clogging of micro emitters. Even with filtration, flushing may be necessary to avoid clogging.

## Soil Moisture Monitoring

Timing of irrigation can be managed through various means of soil moisture sensors including soil moisture tensiometers, theta probes, neutron moisture gauges, digital soil moisture sensors, gypsum blocks and TDR devices. These various devices combined with knowledge of climatic conditions including solar radiation, wind speed, air temperature and humidity can help a grower determine irrigation timing and frequency. Digital weather stations, like the Spectrum WatchDog series and other similar models, can provide accurate on-site weather and climatic data to aid with scheduling irrigation.

A weather station equipped with a rain bucket can be used to measure rainfall received. Photo by Luke Freeman.

Monitoring irrigation needs by measuring soil tension with tensiometers is a quick, easy and cheap method. Tensiometers gauge how much water is in the soil by creating a gradient between the instrument and the soil. As the soil dries it pulls water from the tensiometer, thus creating a vacuum within the tensiometer that causes the needle on the gauge to move and eventually indicate when the soil needs to be rehydrated. Soil tension is measured in cbars, kPa, or sometimes PSI. A higher value indicates greater soil tension, which means that water is being more tightly held to soil particles and less available for plant uptake. Soil is saturated between 0 and 10 kPa of pressure, with 10 kPa being field saturation. Blackberries can comfortably use soil water when soil tension is from 0-30 kPa. As soil tension reaches levels above 40 kPa, blackberries begin to experience physiological stress that can hinder fruit production and newly developing canes. It is ideal to keep soil tension between 10 and 30 kPa in sandy/ loamy soils to minimize plant stress as well as to reduce potential soil pathogen infestations in saturated soils. For more information on soil tension and tensiometers, see Hensley and Deputy (1999).

Various soil types have different water infiltration rates, saturation rates, runoff potential and water storage capacity depending on the soil texture, soil structure and slope. Having multiple weather stations throughout plantings

Tensiometers can be used to measure soil moisture and determine irrigation needs. Photo by Luke Freeman.

can provide accurate soil and climatic data to assist with irrigation decisions. Pan-evaporation measurements are a cost-effective method to estimate daily evapotranspiration rates. The FAO irrigation and drainage paper 56 listed below (Allen et. al. 1998.) contains a more thorough explanation of estimating evapotranspiration and water available to plants within the soil profile.

## Irrigation Systems

Sprinkler or drip irrigation systems can be used, although sprinkler systems are not recommended. Sprinkler systems will wet all the soil during watering and as much as 15% of the water will be lost through evaporation. Sprinkler irrigation also wets the leaves and fruit, increasing fungal diseases. However, because the irrigation equipment does not lie on the ground, there are fewer associated problems with rodents and fewer repairs with sprinkler irrigation than with drip systems. A sprinkler system may also be used as frost protection in late spring in areas where cold snaps could affect developing flower parts. Soils that have slow water intake, tend to crust and seal, or are prone to erosion are not suited for sprinkler systems.

Drip systems are much more efficient than sprinkler systems because water is applied directly to the root zone and is not lost to evaporation. Higher efficiency allows for less water output. Drip irrigation does not apply water to the leaves or fruit, so the incidence of fungal disease is not increased and fruit quality is improved. Rodents often chew on the drip tapes, so frequent monitoring and repair is required.

Drip tube is an efficient means of delivering moisture directly to the root zone. Photo by Luke Freeman.

Regardless of the system chosen, water should be tested for chemical and biological impurities and treated or filtered accordingly.

Mulch can play an important role in water conservation, decreasing the need for irrigation by reducing evaporation of moisture from the soil. Organic mulch, such as woodchips or straw, will also moderate temperature variations, suppress weeds, reduce erosion and add organic matter to the soil. However, mulch can introduce weed seeds and provide a good habitat for rodents. It can be costly and labor intensive to apply new organic mulch every year. Geotextile mulches are available with a 10 to 12 year expected lifetime. The initial cost of these fabrics is high, but may be considered reasonable when taking into account the yield increases and the fabric's long lifetime.

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# Trellising and Pruning 6

## Pruning and Training

Cane training and pruning practices depend on which trellis design is in use, but a general understanding of why the plants are trellised will help decide which branches to train, tip and remove. The goal of the trellis is to support the branching system structurally while expanding the fruiting canopy surface. It also prevents fruit-laden canes from breaking and reduces the incidence of tipping. Photosynthetic capacity is maximized as light penetration is increased and improved air movement mitigates disease incidence. Ease of harvest with minimal canopy manipulation is an added benefit that can also boost production efficiency.

Unless you are growing erect blackberries and raspberries, the prevailing growth habit will produce arched canes that naturally grow up, out and back down to the ground. This allows brambles to propagate from the tip of the plant but is not desired in a commercial setting. Erect varieties do not require trellising but may still benefit from the practice.

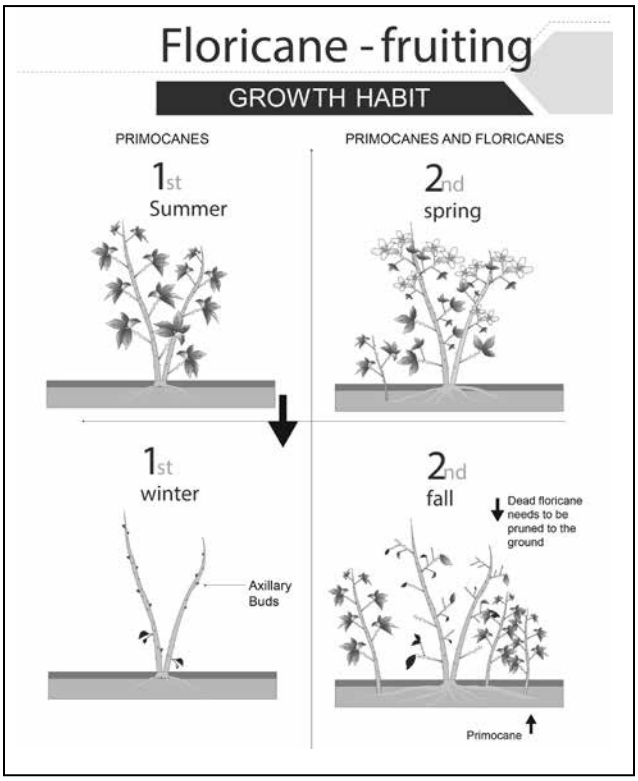
As primocanes (1-year-old canes) grow, lateral canes develop at leaf axils. Tipping primocanes as they grow over the top of the wire will further promote growth of these lateral canes. Suckers that grow parallel with the row direction may be trained into the trellis wires for fruit production. The laterals that emerge at the base of primocanes are too rigid to do this, and may be pruned off to keep them from extending into the aisle. Remove old canes immediately after harvest so that the new shoots develop sturdy canes. Flowers and fruit generally develop only on floricanes (2-year-old canes). The exception to this is the primocane-fruiting varieties, which will bear fruit on primocanes in the fall. Floricanes die after harvest during the second season. This biennial nature requires yearly pruning of dead floricanes. Pruning out dead canes is important for disease and insect control, for growth of new canes, and for ease of management during harvest. Old canes should be destroyed, not left in the rows. Prune carefully to avoid damage to existing canes. Wounds on primocanes provide a point of entry for crown gall and cane blight, so maintaining narrow rows and appropriate cane spacing is important in avoiding these disease problems. The following guidelines will help you prune your canes depending on their prevailing growth habits.

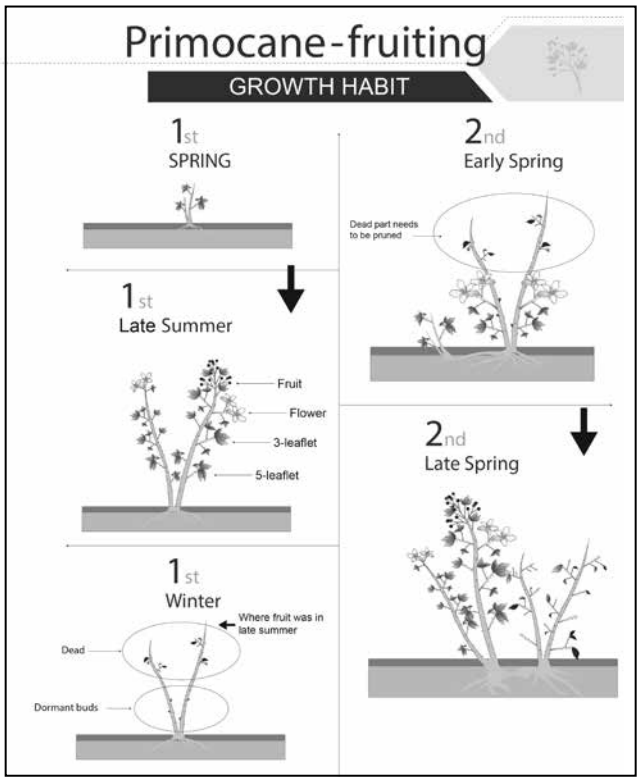
Lateral shoots with flower buds emerge from a raspberry cane that has been tipped. Photo by Luke Freeman.

- ***Erect Types***

Starting in the second year of the planting, primocanes should be tipped at 36 to 48 inches to promote lateral growth, which will increase yields. To tip a cane, the shoot tip should be pinched or cut off. Tipping also prevents the canes from growing too long and breaking easily. Primocanes can also be thinned to keep row widths to 12 to 18 inches and to give laterals more room to grow. In both primocane-fruiting and floricane-fruiting erect growth habits, primocanes should be thinned to about one cane every 8 inches in a narrow row. This will reduce wounding from canes rubbing on each other, and will allow for pruning without causing major injuries to the standing canes. One cane per 8 inches will also allow for optimal growth and productivity. Winter pruning consists of pruning laterals back to 12 to 18 inches and removing dead or diseased canes. Tipping and lateral pruning are time consuming practices, but both will increase yield and fruit size.

Floricane blackberries and raspberries grown on a T-trellis in a high tunnel at the University of Arkansas. Photo by Luke Freeman.




- ***Trailing and Semi-erect Types***

With both trailing and semi-erect types, primocanes are not tipped. Once floricanes have died, they should be removed, and primocanes should be trained onto trellises. During dormancy, select eight to 10 vigorous primocanes for training, and remove the remaining canes. Canes should be pruned back to 6 to 8 feet and laterals to 12 to 18 inches.

- ***Primocane-Fruiting Types***

Although primocane-fruiting blackberries can be trained and pruned in exactly the same way as erect floricane-fruiting varieties, it is better to mow the canes down in the winter. This helps break disease and insect cycles, and reduces the labor required in selectively pruning out dead floricanes. It is still recommended to tip primocanes to 27 inches during the season to encourage the production of laterals before the canes begin producing flowers. Once canes begin to flower, it is to late to tip. Tipping will cause the harvest to be more concentrated in the beginning of the harvest time.

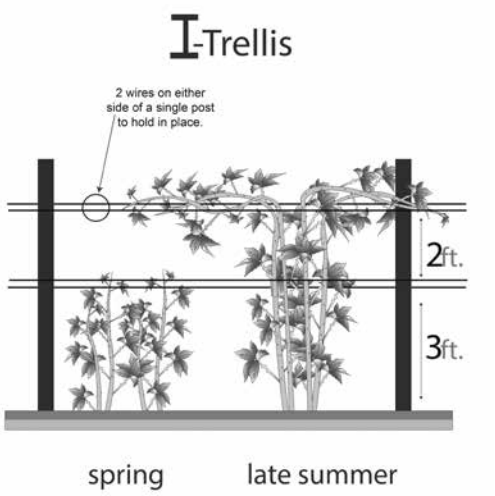
## Trellis Systems

Blackberries and raspberries of all growth habits should be trellised, but each growth habit requires a different trellising system. The three most common trellis systems are all post-and-wire systems: the I-trellis, the two-wire trellis, and the V-trellis. Typical applications are discussed below; however, various adaptations to these systems do exist commercially. The best system to use depends on multiple factors specific to the site such as plant growth habits, vigor, environmental factors and cultural practices in use.

- ***I-trellis***

The simplest way to trellis raspberries and blackberries is to use an I-trellis. This consists of a single wire,

3 to 4 feet above the ground, to which the canes are tied. It serves as a basic support that prevents cane breakage. The canes are not spread out, so this system will not improve light penetration. Lateral fruiting canes may be lower in the middle portion of the trellis due to this lack of light. It also leaves little room for primocanes to grow, forcing them into the aisles. Both the I-trellis and the two-wire trellis are typically used for trailing types.

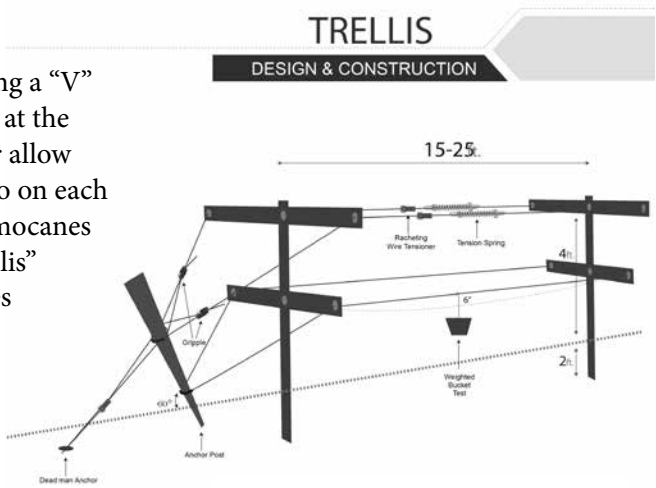


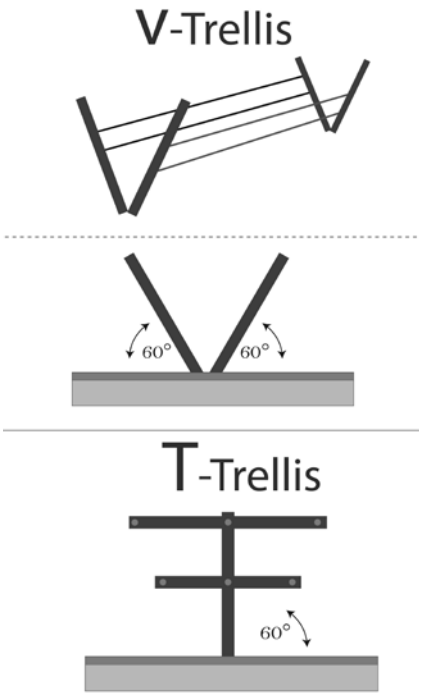

- ***Two-wire trellis***

The most common system in use is the two-wire trellis. Posts are set 20 to 24 feet apart in the row, with two wires stretched between the posts. The lower wire should be set 3 feet from the ground, and the second wire should be 5 feet from the ground. Floricanes can either be tied in a fan shape or woven through the wires.

- ***V-trellis***

V-trellising places canes at 20 to 30-degree angles forming a "V" shape. This system uses posts with crossbars or posts set at the appropriate angle. Angled T-posts with a wooden spacer allow for easy trellis assembly. There are usually four wires, two on each side. Floricanes are tied to both sides of the "V," and primocanes are allowed to grow in the center. The "alternating V-trellis" is an adaptation of the standard V-trellis where floricanes are trained to one side of the "V" and primocanes to the other side. Having primocanes and floricanes alternate sides of the trellis each year simplifies management and harvest. In both V-trellis systems, fruit is very accessible, and there is limited interference between primocanes and floricanes.

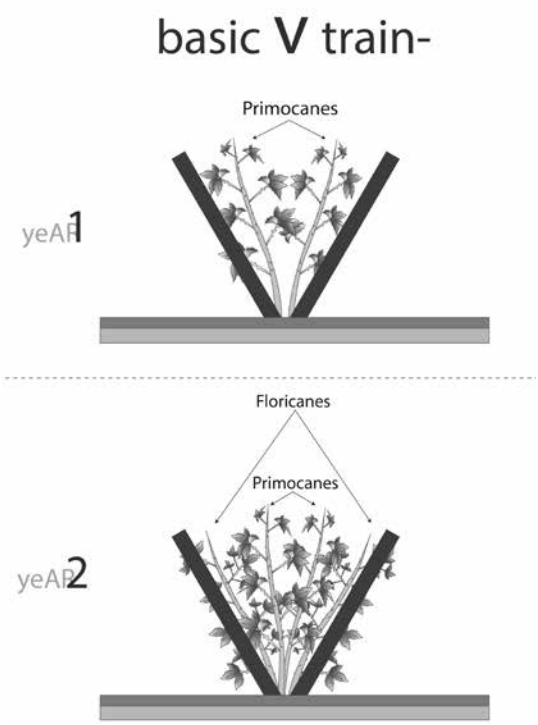


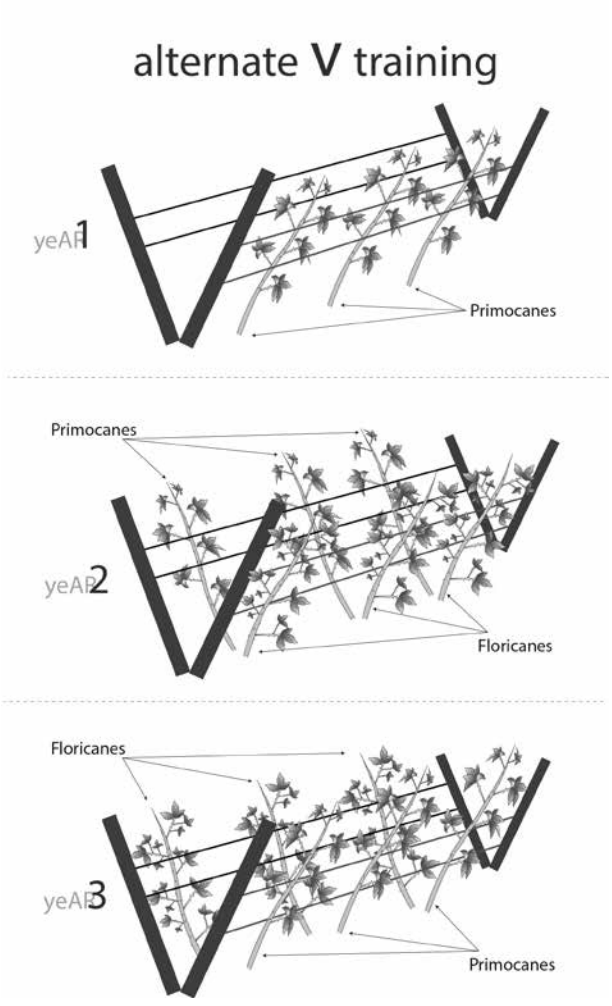




## Trellis Construction

Several factors must be considered in constructing even a simple trellis if it to be effective and long-lasting. High tensile corrosion resistant wires have greater weight resistance (both for breaking point and yield point) than low-carbon wires of the same gauge. Select a wire gauge that is sufficient to hold the weight of the crop without yielding. In most cases, 11 or 12 gauge high tensile is sufficient for the top wire, with 14 gauge for the lower wire. A trellis should be constructed with approximately 300 pounds of tension.

Solid, durable posts should be selected to secure the wire, and they should be anchored at least 2 feet into the soil. Both wooden and metal posts can be strong enough. Treated lumber, untreated eastern red cedar, or white cedar (ashe juniper) make durable post material. Lumber posts should be 4 inches in diameter. Metal T-posts may be used as well. Since they are not as rigid, the distance between T-posts should be less than 15 feet.




The end post is usually a post of the same type of material as the rest of the trellis, but is usually placed at 60-degree angle from the ground. This angle allows the end post to provide a stable counter force to the inward pull of the trellis wire, while allowing the downward tension of the anchor to hold it stable. The anchor should be 3 to 4 feet long and reach approximately 30 inches in depth.

When the end posts and anchors are secure, the wire is attached. A nail or bolt will keep the wire from slipping along the end post. Ratcheting wire tensioners should be used to bring the trellis wire tension to between 270 and 300 pounds.

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# Insect and Mite Management 7

## Introduction

Insects, diseases and weeds can challenge blackberry and raspberry production in Arkansas. It is impossible to eliminate all pests, but you can manage pests and keep them at low-enough levels to have a healthy planting and good production. It is important to manage pests before you have a problem; the old adage, an ounce of prevention is worth a pound of cure, applies. There are many strategies that manage pests, especially weeds and diseases, by building a planting environment that discourages them. First, build a planting that suppresses pests and improves bramble plant health, and then focus on practices targeted toward specific pests.

## Pest Management

A sustainable pest management program requires that the grower: 1) recognizes stages of each pest; 2) recognizes damage caused by each pest (Fig. 2); 3) knows pest phenology (when pest can be detected in the field; when pest is most vulnerable to a control tactic; when pest may cause economic damage); 4) knows how to monitor for presence of each pest; 5) makes pest management decisions based on monitoring; 6) knows vulnerable stage of each pest for each management tactic; 7) selects most appropriate management tactic for given pest and production system; 8) selects insecticides that conserve natural enemies; 9) rotates modes of action when applying insecticides/miticides to delay development of resistance in pests; 10) evaluates effectiveness of tactic; and 11) attends yearly fruit workshops to get updates on pest management.

## Mites

The two-spotted spider mite (TSSM), McDaniel mite (like TSSM but has four to six spots) and red Carmine spider mite may suck out epidermal sap on

Eric Riddick of the USDA-ARS releases C-Mac ladybugs (C. maculata) in a screened blackberry high tunnel to control aphids. Photo by Luke Freeman.

A blackberry shoot tip infested with aphids that are guarded by ants. Photo by Luke Freeman.

underside of leaves and damage bramble leaves. In May, these spider mites walk or aerially disperse from adjacent weedy broadleaf host plants to leaves on the lower blackberry cane. Mites gradually disperse upward to younger leaves, causing more leaves to have yellow-white spots on upper leaf surface (bronze), and may kill the cane. In early May, begin biweekly inspections for the presence of spider mites on the underside of 20 blackberry leaflets from the lower canopy, especially those showing yellow-white spots. Use a 10X to 20X magnification hand lens or headband magnifier (3.5X) to see mites. A miticide application is needed if more than 80% of leaves inspected are infested with spider mites (more than 5 mites per leaflet).

## Aphids

In spring, as primocanes emerge from the soil and shoots develop on floricanes, begin biweekly inspection of shoots and terminals across the planting for aphids. These aphids build up to large numbers on terminals and new flower buds, reducing fruit yield. Aphids may be tended by ants, which prevents biological control by predatory lady beetles and reduces the number of aphids that get parasitized by wasps such as *Aphidius colemani*. An insecticide should be applied if more than 60% of terminals are infested with aphids.

## Stink Bugs, Japanese Beetles and Green June Beetles

Stink bugs will feed on green-to-ripe berries from May to the end of the primocane harvest in October and often leave a "stink bug" taste on the ripe fruit. In June and July, Japanese beetle adults emerge from the soil, mate, lay eggs in the soil (the larvae feed on green roots), defoliate canes and feed on flowers and ripening berries, causing yield loss. From late June through early August, green June beetle adults will emerge from the soil, usually after a significant rain moistens the soil so they can dig to the surface. Adults fly over the surface of a pasture looking for a mate. Once they mate, the female digs into the soil to lay eggs, where the the larvae feed on decomposed manure. A week after emerging, the hungry adults disperse to fruit plantings to feed on ripening berries, causing significant fruit damage. These three pests need to be removed by hand or treated with insecticide as needed.

## Spotted Wing Drosophila (SWD)

From mid-June to late October a newly introduced pest, the spotted wing drosophila (*Drosophila suzukii*), inserts eggs into ripening and ripened berries in which the larvae feed. When mature, the larva drops to the soil where it pupates and then emerges as an adult fly — all within 10 to 25 days, depending on temperature. The recommended management program involves several tactics: 1) thin or open up canopy to improve future pesticide spray coverage and make picking easier; 2) three weeks before ripening starts, begin weekly monitoring of SWD traps (bait with either a: yeast bait = 32 oz water + 2 tbsp yeast + 4 tbsp sugar that you let ferment 1 day, then add 4 fl oz to trap; or Trécé AB lures and apple cider vinegar) in earliest ripening fields and adjacent landscapes where there may be wild SWD host

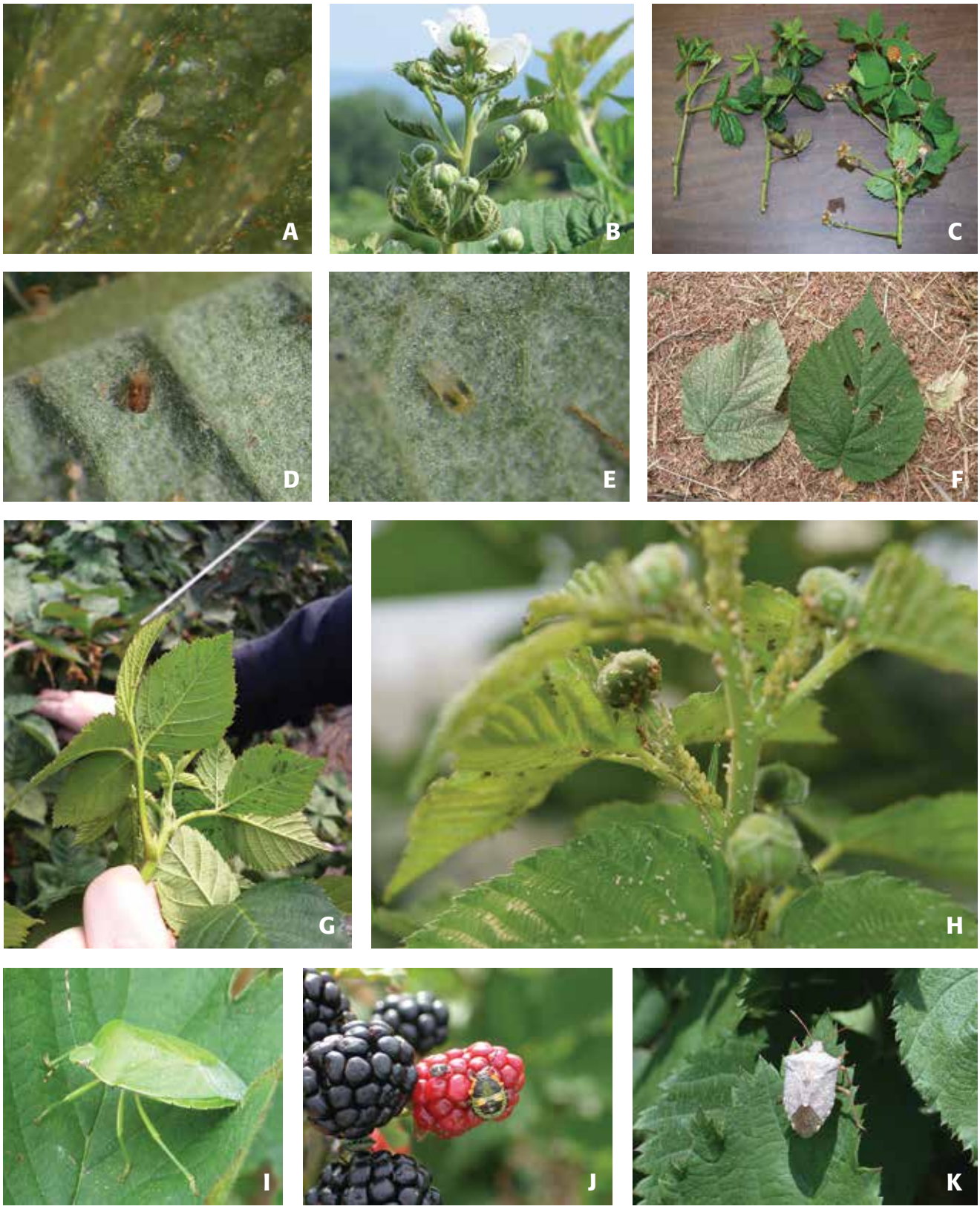


Figure 1. Pests of blackberry: (A) Broad mite adults and white spotted eggs; broad mite damaged terminals in (B) July (upward cupped leaves) and (C) October (downward cupped leaves); (D) Carmine spider mite; (E) twospotted spider mite; spider mite caused (F) white stippled leaf on left versus healthy leaf on right; (G, H) aphids on blackberry shoot tips; green stink bug (I) adult and (J) immature; (K) brown stink bug adult. Photos by Donn Johnson.


Figure 2. Pests of blackberry: (A) Japanese beetle adults and blackberry feeding damage; (B) green June beetle adult; spotted wing drosophila (C) flies, (D) eggs laid under skin of blackberry, and (E) larva in raspberry; rednecked cane borer (F) adult, (G) larva in pith which causes (H and I) gall on primocane. Photos by Donn Johnson.


Figure 3. Pests of blackberry: raspberry crown borer (A) adult, (B) brown egg on underside of leaf, (C) larva tunneling in lower cane, (D) cross section of lower cane showing larva inside its tunnel, (E) raspberry crown borer larva, (F) pupal skin on lower cane after adult emerged, and larval tunneling caused (G) dead cane (shepherd's crook). Photos by Donn Jonson.

plants; 3) weekly, from first fruit ripening through harvest, apply registered insecticides (reapply after rain); remember to rotate between insecticides with different modes of action to delay development of resistance in SWD population. An alternative tactic is to use row cover or screen (mesh < 1 mm holes) during harvest in small plantings or on sides/ends of high tunnels to exclude SWD from laying eggs on fruit; 4) weekly, evaluate spray effectiveness by looking for SWD eggs or larvae in samples of 30 ripe fruits; 5) daily, pick ripe fruits and keep the crop picked clean to minimize buildup of SWD in a fruit planting, and immediately refrigerate or freeze fruit upon harvest to slow down egg and larval development and reduce losses to fruit rot from pathogens introduced during egg-laying; 6) manage field sanitation by removing all overripe fruits and those on the ground to minimize buildup of SWD in a fruit planting; and 7) stay informed about new findings and management tactics for SWD.

The C-Mac ladybug is effective in controlling aphid populations, but the presence of ants guarding the aphids will reduce their effectiveness. Photo by Luke Freeman.

## Red-necked Cane Borer

In May and June, the red-necked cane borer lays eggs on primocanes. The larvae girdle the cane, causing a gall that predisposes cane to winter damage and reduces yield. This borer is controlled by applying an insecticide timed against the adult.

## Raspberry Crown Borer

The raspberry crown borer adult mates and lays eggs on the underside of leaves from mid-September to mid-October. The larvae hatch, crawl to the base of the cane and chew into the cane just below the soil line to overwinter. The following spring and summer, the larvae tunnel into the crown and then into the lower canes, causing canes to die to the ground (this appears like a shepherd's crook). Over several years the damaged crown produces fewer healthy canes and yield is reduced. A soil drench insecticide is applied in early November to kill the overwintering borer larvae.

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# Weed Management 8

## Introduction

By competing for nutrients, water and light, weeds reduce both the quantity and the quality of berries harvested. In addition, robbing plants of sufficient resources weakens canes and renders them more sensitive to diseases, drought and cold temperatures. In some cases, air circulation is restricted when weeds grow under plants, which enhances the severity of diseases that benefit from longer periods of leaf wetness. Proliferation of climbing perennials such as honeyvine milkweed (*Ampelamus albidus*) and morning glory (*Ipomoea* spp.) can interfere with the harvest, while invasion of white clover and other legumes can encourage deer browsing.

The design of approaches to weed control in blackberries and raspberries depends first upon proper identification. It is important to recognize that selection of tillage or herbicide practices starts with plant identification. Weeds fall into one of three life cycles: annuals (winter or summer), biennials or perennials. Among these, plants can be classified as dicots (broadleaves) or monocots (grasses, sedges). Growers are urged to use online and published resources (listed below) for weed identification purposes. In addition, experts from industry or university extension agencies are available to assist with identification.

It is good practice to keep a 4-foot-wide area (2 feet on each side of the row) weed free. It is especially important to keep weeds away during the first two years of plant establishment. Once a dense hedgerow of plants is established, the crop itself will help suppress weeds. Maintaining a weed-free zone can be difficult, but mulches help by suppressing most annual weeds. Selective herbicides such as Poast are effective against grasses and have little to no negative impact on blackberries. For organic growers, hand weeding will be necessary, but mulch in the rows and cover crops in the row middles can be a successful strategy. Even conventional growers should make use of cover crops to suppress weeds in the aisles. This will keep the weeds encroaching on the rows to a minimum. The most effective weed management systems result from an integration of multiple tactics.

## Mulch

Organic (wood-based) mulch can help improve soil fertility and suppress weeds. However, it is only effective against annual weeds. Perennial weeds such as onion, curly dock, Johnson grass and Bermuda grass have enough reserves to grow past the mulch. The use of wood-based mulches can be effective if they are 4-to-6-inches thick and allow crowns to breath. Soil fertility improvements from mulch help perennial weeds just as much as they help brambles. Thus, mulch is helpful, but is not a complete weed management strategy by itself.

Woodchip mulch can be used to suppress weeds within the row, conserve soil moisture, and add organic matter. Photo by Luke Freeman.

When acquiring mulch make sure that the mulch itself is not importing new weeds. Rice hulls, wood shavings or sawdust from sawmills can be a good and sometimes inexpensive source of mulch. If you use sawdust or any fine wood mulch, remember that as microbes break down the carbon in the mulch they will take up nitrogen from the soil. This nitrogen tie-up will reduce nitrogen availability for the bramble plants. You may need to add up to 50% more nitrogen fertilizer to account for the microbial tie-up.

You can use synthetic mulches (plastic) on the beds prior to planting. Black plastic mulch will last one or two years and is an effective weed suppressant in the beds. It may also suppress some primocane emergence and raise soil temperature. Be sure the plastic is of sufficient thickness (a minimum of 4 mm is recommended). Woven landscaping fabric is more expensive, but can last many years and suppresses weeds effectively.

Fast-growing cover crops such as sorghum-sudangrass can be grown prior to planting to suppress summer annual weeds. Photo by Luke Freeman.

## Cover Crops

Cover crops can be very useful both for suppressing weeds in the aisles and for improving soil fertility. When properly established, a perennial fescue and white or crimson clover cover crop can keep Bermuda grass out of the aisles. Mowing height can be adjusted to give advantage to the cover crop. If Bermuda grass or another low-growing, spreading weed is a problem in the planting, a fescue and clover cover crop can be mown at 5 to 6 inches or not mown at all. This allows the cover crop to form a dense canopy and shade out the lower-growing weeds.

Clean cultivation is not recommended because of increased erosion and soil compaction from continuous cultivation and decreased organic matter. The use of cover crops and minimal shallow cultivation is recommended in aisles.

## Cultivation

Mechanical cultivation can also be used effectively for weed control. Cultivation serves to break off, bury or uproot small weeds, and is most effective under moderately dry conditions to encourage desiccation of weeds. There are numerous types of mechanized equipment for removing weeds. Important considerations for cultivation include the type of soil and soil slope. This will help determine the extent of erosion, which can be extensive on sloped soils. A good rule of thumb is that cultivation equipment should not come within 2 inches of the canes to avoid damage, and not go greater than 2 inches deep, as this could damage feeder roots. Cultivation is most effective on annuals or small biennials, as damaging these weeds can result in plant death. However, many perennial weeds are propagated in a vegetative manner, and cultivation can serve to induce greater shoot emergence of these plants.

Mowing is another form of mechanical weed control, and can be effective for managing seed production of weeds within the drive row. It should be noted that some plants produce viable seed five days after flowers are fully open (dandelion, for example). Also, as days get shorter (after summer equinox), annual plants begin to flower and produce seeds, with seed production greatest in August and September. Therefore, some mowing may be necessary for seed head suppression, despite the lack of tall vegetation in the

Synthetic weed barrier or landscape fabric can be used to suppress weeds within the row. Photo by Luke Freeman.

drive row. For grass groundcover maintained in row aisles, top growth should not be cut below a height that weakens plants. Excessive mowing can reduce shoot and root growth; a lack of sufficient leaves will not allow proper photosynthesis to rebuild shoots and roots. The proper mowing height varies among grass species.

## Herbicides

Herbicides can be used effectively to manage weeds. Just like other weed management tools, it is important to consider the cost of each herbicide against the benefit it will provide. In the broadest sense, herbicides are either selective (affect some plant species with minimal or no influence on others) or non-selective (will injure all plants contacted). Also, herbicides can be contact (only injure plant tissue that is treated with herbicide) or systemic (herbicide affects the tissue that is contacted as well as other tissue at some distance above or below ground). Finally, some herbicides continue to provide weed control for some period of time (residual). Prior to use, growers must be aware that a number of herbicides are restricted use pesticides, and their purchase and use requires a pesticide applicator's license in the state that applications will be made. Generally speaking, it is best to use selective herbicides to control specific weeds. Although they are labeled for use in blackberries and raspberries, broad-spectrum systemic herbicides, like those containing glyphosate, should not be used. Blackberries and raspberries produce canes from roots several feet from the original plant. These runner canes may then take up the herbicide, damaging the whole plant.

Consult all herbicide labels prior to use in order to determine proper protective equipment for application, as well as identification of use rates, intended target species, recommendations of surfactants and other restrictions. Any use of herbicides not labeled for use on your crop can result in sizable fines, confiscation and destruction of all crops harvested from treated plants. It is the responsibility of the applicator and holder of the pesticide applicator's license to ensure compliance with herbicide label guidelines and federal/state environmental laws.

It is important to understand that extensive use of herbicides can lead to selection for weeds resistant to herbicides, or populations with tolerance to herbicides. Therefore, growers are urged to rotate herbicide use based upon how the herbicides kill plants (mode of action), and use more than one herbicide (that is, herbicides with different modes of action). No single herbicide program should be used continuously over multiple seasons. The selection of herbicide-resistant weeds can result in long-term consequences for not controlling specific weed species with that herbicide. For additional information, go online to www.weedscience.com or ask your university extension representatives.

Growers must also be aware of herbicides that can leach through the soil to groundwater sources, or runoff with soil into surface waters. The Environmental Protection Agency (EPA) has designated triazine herbicides (atrazine, simazine, cyanazine) and the acetanilide herbicides (alachlor and metolachlor) as requiring a Specific Pesticide Management Plan due to their significant risk for groundwater contamination. A site with a shallow water table (within 20 feet of the soil surface), permeable sub-surface materials, or proximity to a river or streams makes it especially vulnerable to ground water contamination from herbicides.

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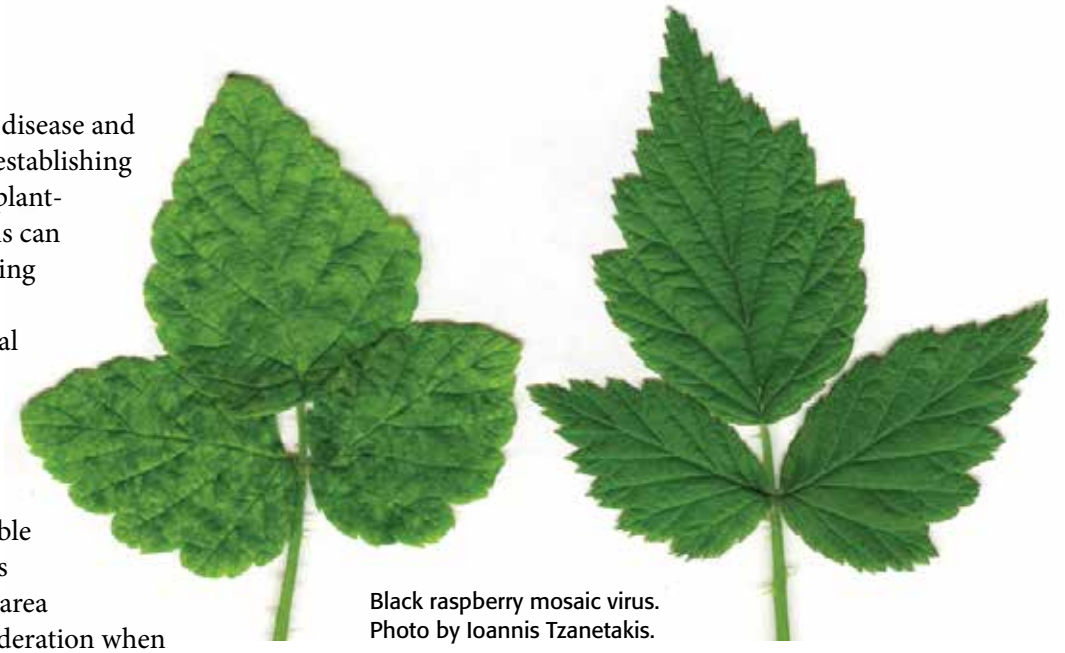
# Disease and Virus Management 9

## Establishment

It is important to consider disease and virus management before establishing a raspberry or blackberry planting. Many disease problems can be minimized before planting occurs. Site selection and cultivar selection are critical choices with regard to disease management.



Black raspberry mosaic virus.
Photo by Ioannis Tzanetakis.

### • *Cultivar Selection*

In addition to other desirable traits, resistance to diseases prevalent in your growing area should be taken into consideration when selecting a cultivar. This information is generally included in the cultivar guides made available by many universities. Regardless of cultivar, it is critical that planting stock be obtained from a nursery that certifies its material to be disease-free and virus-indexed. These plants will usually present a larger initial cost, but could prevent the need to replant an entire field after just a year or two.

### • *Site Selection*

Just as it is important to test soil for nutrition and other characteristics, it is important to ensure soil is free of plant-parasitic nematodes. Nematodes can vector or transmit viruses and there is nothing to be done to control them once plants are established. Soil samples should be collected from the site, kept cool and moist, and sent to a lab for analysis. If significant levels of plant-parasitic nematodes are detected, they can be eliminated with biofumigant cover crops, solarization or chemical fumigation.

To avoid some of the more persistent bacterial and fungal pathogens, it is advised that brambles not be planted following other fruit crops or solanaceous crops. Choosing a site with good soil water drainage is also critical, not only for minimizing root rot, but because pathogens do not survive in dry, well-drained soils as compared to wet, poorly-drained soils. Selecting a well-drained site will make management easier in the long run.

## Cultural Controls

Once berries are planted, proper sanitation and management will aid in controlling diseases. During dormancy, all spent floricanes should be pruned out and destroyed. Remove and destroy diseased primocanes. Fallen leaves should be raked and disposed of before bud break. Keep pruning equipment clean and sanitize it between cuts to stop mechanical spread of disease. Ethanol, isopropanol, calcium hypochlorite, chlorine dioxide, sodium hypochlorite, hydrogen peroxide and peracetic acid are all disinfectants approved by the National Organic Program.

Overhead irrigation or other practices that splash water onto plants should be avoided to prevent fungal dispersal. Consider the source of irrigation water and test for the presence of water-borne pathogens. Improved circulation and air movement will dry the foliage and canes more quickly after rain or irrigation, reducing the potential for infection. Air circulation can be improved by proper spacing, thinning, weed

Raspberry leaf blotch. Photo by Ioannis Tzanetakis.

control and sucker removal. An appropriate trellis system can also improve air circulation.

Pick fruit regularly and thoroughly. Leaving ripe fruit on the cane increases the likelihood of fungal diseases and attracts insects that can damage intact fruits.

## Management of Insect Vectors

### • *Nematodes*

While the pre-plant site preparation should ensure that plant-parasitic nematode populations are low, nematodes can be introduced through infested soil or contaminated equipment. To avoid this, equipment used on other fields should be cleaned of soil debris before being used.

### • *Aphids*

In addition to causing damage to canes, aphids are a major vector of several important viral diseases that affect brambles. A number of raspberry and blackberry cultivars are resistant to specific aphid vectors, but monitoring for the presence of these and other insect pests should be continuous. Release of ladybugs as biological control agents can be used to suppress aphid populations as soon as they are observed.

### • *Other Insect Pests*

Even insect pests that do not directly vector specific diseases can increase the incidence of disease, particularly if they cause damage to the fruit. Infestations of green June beetles, for example, can lead to significant fruit rot. Mite infestations can also exacerbate symptoms of root rots and wilts. Monitoring for these pests is the first step to maintaining control. Many insect pests can be controlled through biological means, including parasitic wasps, ladybugs or mantids. Others can be controlled with simple vinegar or alcohol traps. See the Insect Management section for more information on insect control.

## Organic and Biological Controls

If disease breaks out despite best management practices, there are biocontrol options available. Biological control of disease involves the introduction of a competitive or antagonistic microorganism to prevent the pathogen from colonizing the plant. The approved-use labeling of these biocontrol products should be carefully checked, particularly for organic producers. Not all products are approved for organic production in all states, or for use in all crops. (Serenade is currently labeled for use in both blackberries and raspberries.)

There are also a handful of fungicides and bactericides that are labeled for organic use, with lime sulfur and copper-based products being some of the most widely effective. When using these products, be aware that copper-based products can be phytotoxic to young tissue and be especially conscious of recommended application rates and timing.

## Chemical Controls

For conventional producers, there are pesticides on the market for managing disease once it has emerged. When selecting an appropriate pesticide, consider the mode of action of a given chemical: if multiple sprays are necessary, alternate chemicals with different modes of action to avoid development of resistance. Mode of action charts are available online from a number of universities or any extension office.

Pay careful attention to label rates to minimize runoff and use care when applying to avoid overspraying. Check spray equipment regularly to ensure that it is

Blackberry yellow vein disease. Photo by Ioannis Tzanetakis.

functioning properly. Accidental application of excess material is common and easily avoidable. When used carefully, chemical controls are a valuable part of a sustainable disease management program.

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# Farm Safety 10

## Introduction

Farm safety starts with increased awareness. Know the hazards that you and your workers are being exposed to, and make a conscious effort to prepare for emergencies. Discuss these emergency procedures with your employees, whether the emergency is a spilled chemical or an injury out in the field. Every farm should have a plan for emergencies, especially those in rural areas that may be far from a hospital. Workers can be protected from these dangers through proper training and safety precautions. First-aid kits are a must, and poison center contact phone numbers should be easily visible. The hiring protocol should include steps to acquire emergency contacts in the event of an emergency. See the chapter on Business Management for information on liability insurance.

## Tools and Equipment

Agriculture uses a diverse array of tools and equipment. Always read and follow instructions in equipment operator manuals and on product labels. Keep equipment and tools in good operating condition. Poor maintenance increases the likelihood of equipment damage and personal injury. Know and follow recommended operating practices. Know the critical risk points for the equipment you are using so that risks can be avoided. Schedule safety checks into your operating schedule to make sure that all safety devices are in place and working properly. It is a good idea to provide appropriate clothing and protective gear such as eye protection, hearing protection and heavy-duty gloves for jobs that require them. Clothing and long hair must not be loose when working with heavy machinery, and workers should always wear closed-toe shoes. It is a good idea to mark areas where adequate clearance needs to be maintained around dangerous equipment.

## Fertilizer and Pesticide Safety

Always review and follow instructions in material safety data sheets (MSDSs) and on labels that come with chemical products. Communicate these dangers to your workers. Chemicals used on the farm can be toxic or combustion hazards, making it important to carefully consider how chemicals such as fertilizer and pesticides will be stored on the premises. The location should be such that if the containers were to leak, they would not pollute any nearby ponds, wells or other bodies of water. One way to achieve this is to load the pallets onto a concrete slab in a storage room. The concrete provides a barrier so that chemicals do not leak into the groundwater, and the room will protect the packaging from exposure to the elements. In some areas, farmers may need to lock up fertilizers to prevent theft.

If chemical pesticides are part of your production, it is a good idea to have a designated area for mixing and loading pesticides prior to application. You will

It is important to have a dedicated area for pesticide mixing with appropriate safety features. Photo by Luke Freeman.

Pesticides should be stored off the ground in a secure facility. Photo by Luke Freeman.

need a certified pesticide applicator's license to purchase and apply restricted-use pesticides. All pesticide labels and MSDSs should be read and understood before application. As with fertilizers, chemical pesticides and herbicides should be stored in such a manner that they do not pollute nearby bodies of water.

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# Harvest, Post-Harvest and Food Safety 11

## Harvest

Blackberries and raspberries are delicate and must be harvested and handled with care to maintain quality. Blackberries have a receptacle that remains intact within the fruit. Raspberries have a detached receptacle, which gives them a hollow core and makes them much more delicate. No matter the type of berry, high quality berries are firm, uniform, not leaky and free from any insect or disease damage.

Blackberries are ripe and ready for harvest when they are shiny to dull black and are easy to separate from the stem. The last days before blackberries are fully mature are critical for size and flavor development, thus soil moisture and nutrients and environmental conditions are important during this period. The appropriate stage of ripeness will vary between cultivars. Mottled (50% black) fruit should not be harvested as the acidity is very high and the sugar content is low. The harvest period for blackberries lasts four to seven weeks depending on the cultivar.

Raspberries are ready to be harvested when they are easily separated from the receptacle. Raspberries are more fragile than blackberries, but it is acceptable to harvest them before they are at peak ripeness. In fact, recent research shows that there are benefits to harvesting raspberries at the pink stage with little compromise in berry quality. Berries picked before full maturity are firmer and less leaky than fully ripe berries and will reach comparable levels of soluble solids, acids and flavor after a few days in storage.

Berries should be harvested thoroughly every one to three days in the cool of the morning, while they are still firm for highest fruit quality. Frequent harvest

Natchez blackberries are harvested at the Arkansas Agricultural Research and Extension Center in Fayetteville. Photo by Luke Freeman.

may help to reduce spotted wing drosophila (SWD) pressure since this pest targets the ripest fruit. As temperatures increase throughout the day, berry firmness decreases. Although it is best to pick berries in the morning, they should be free from any moisture caused by dew or rain to reduce disease pressure. Harvesting fruit directly into marketable containers will reduce handling and damage to the fruit. To avoid crushing the berries on the bottom of the containers, do not fill the containers too full. Berries should not be piled more than two to three berries deep to avoid crushing. Culled berries should also be picked and then destroyed away from the berry field in order to reduce mold spores and SWD population that may be in the berries. Some growers may choose to go through the field twice — once to pick marketable fruit and then again to pick culled fruit — in order to avoid contaminating the good fruit with spores.

## Post-harvest handling

Blackberries and raspberries have a short shelf life. This varies among cultivars, but environmental conditions such as soil moisture, weather and plant nutrition can have a significant effect on shelf life and quality. Harvested fruit should be protected from direct sunlight, as this causes blackberries to turn red and become bitter. Berries should be cooled as quickly as possible after harvest to decrease respiration and reduce berry quality decline. Berries that maintain a high respiration after harvest will lose firmness and soluble solids, and may shrink in size. A good rule of thumb is that for each hour post-harvest without cooling you will lose a day of shelf life.

Berries can be harvested into pulp paper baskets or plastic clamshell containers. Photo by Luke Freeman.

The best type of cooling system for blackberries and raspberries is forced air, which can quickly remove field heat between multiple layers of containers or flats. However, many small operations utilize room cooling. Stacking berries should be minimal in a cooling room to most effectively remove field heat. A household fan can be used to increase heat dispersal from the berries. Once the field heat is removed, flats can be stacked. Berries should be stored at 30 to 35°F and at 90 to 95% relative humidity. Harvesting berries that are free of moisture initially will reduce disease, and storing them in high humidity and low temperature will slow the breakdown of the fruit tissue and extend the shelf life. These conditions will also slow the growth of any fungal pathogens on the berries.

When transporting fruit to market the temperature should be maintained as cold as possible, as low as 30°F. Care should be taken to minimize rough handling, jostling and high temperatures to minimize deterioration of quality.

## Food safety

Blackberries and raspberries are often not washed by consumers before consumption and are typically eaten fresh, making good food safety practices critical. Growers can undergo Good Agriculture Practices (GAP) certification if the market demands, but regardless, it is in the best interest of the grower to use preventative practices throughout the season to help minimize the risk of contamination. This section will not review GAP practices but will highlight food safety considerations on the farm for the harvest and post-harvest period. Further information on GAP can be found in the References section at the end of this chapter.

It is very important that efforts are placed on preventative measures to reduce the risk of contamination with human health pathogens since blackberries and raspberries are not washed before being marketed. The three most common sources of contamination are through water, on hands and through animal and human feces.

Field handwashing stations can be constructed inexpensively from salvaged materials. Photo by Michele Schermann, University of Minnesota.

## Water

Municipal water is the safest source of wash water, with ground water as the next best option and surface water the least safe. Ground and surface water should be tested for contamination throughout the season, but surface water can be more variable since it is exposed to animal contact and animal waste. Most importantly, potable water should be used whenever water might come in contact with the fruit, such as for frost protection, pesticide application or a mist cooling system in a high tunnel. It is common and acceptable to use ground or surface water for drip irrigation since there is minimal chance for berries to come into contact with the water.

## Workers

Train employees on proper food safety procedures and policies for your operation and provide them with appropriate tools to follow the procedures. Workers should have clean hands and clothes or wear gloves and aprons while handling fruit to prevent the spread of any human pathogens. Picking into marketable containers also reduces the opportunity of potential contamination through contact with hands. Workers that are ill should not handle marketable fruit. Hand-washing stations and bathroom facilities should be equipped with potable water, soap and paper towels. U-pick operations should also provide customers with similar facilities. Some creative options for hand-washing facilities can be found in this resource from N.C. Cooperative Extension: http://www.smallfruits.org/CoAgentTraining/Posthavest2012/07a%20Hand-washing%20unit%20one-pager.pdf.

## Waste

Fruit that has any bird or animal feces on it should not be harvested with marketable fruit. Hands picking the contaminated fruit may then contaminate the good fruit. High quality fruit that has been on the ground or has been dropped should be sold through a processing market rather than a fresh grade market.

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Cool storage facilities are essential for a berry operation since berries must be cooled immediately after harvest to prolong shelf life. Photo by Luke Freeman.

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Food Safety Begins on the Farm. A Growers Guide. http://www.gaps.cornell.edu/documents/edumat/FSBFEngLOW.pdf

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Good Agricultural Practices for the Production and Handling of Strawberry, Raspberry, Blackberry and Blueberry, http://fbns.ncsu.edu/extension_program/documents/GAP_berries.pdf

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Hand Hygiene for Farm Management, http://norocore.ncsu.edu/wordpress/wp-content/uploads/2014/04/berry-for-mgmt.pdf

Harvester's Keeping Your Hands Clean, http://norocore.ncsu.edu/wordpress/wp-content/uploads/2014/04/berry-workers.pdf

N.C. Fresh Produce Safety, http://ncfreshproducesafety.ces.ncsu.edu/

The National GAP Program, http://www.gaps.cornell.edu

The Produce Safety Alliance, http://producesafetyalliance.cornell.edu/

University of Minnesota Agriculture Health and Safety Program, How to build a field hand washing station in 10 easy steps for under $20. http://safety.cfans.umn.edu/files/2011/12/Handwashing_station_instructions.pdf

# Business Management 12

## Farm Business Structure

When starting a new farming operation, it is important to decide how you want to structure your business. To achieve your economic goals, you should choose the legal business structure that best enhances your potential for success. Sole proprietorship, business partnerships, business joint ventures, corporations or cooperatives are some of the options. The reading list below includes links to articles that assess the advantages and disadvantages of each kind of business structure.

## Farm Business Management

To manage an agricultural production business, the manager needs to oversee business operations by providing leadership and organization during the production process. A primary responsibility of a business manager is to identify and engage in production and product distribution practices that reach profit goals and meet environmental and other government standards. Additional responsibilities of a farm business manager include: selecting and supervising workers, keeping a reliable and consistent labor supply, providing training if needed, planning production and harvest activities, creating production and financial budgets, organizing routine maintenance, keeping records and communicating with potential employees and product buyers.

## Labor Issues

Agricultural employers must provide information about the working terms and conditions of the job to their employees. According to the United States Department of Labor (2014), employers have different obligations for different types of workers. The employer must provide contracts for workers that do not live permanently in the area; workers living permanently in the area can ask for a written copy of the contract if needed. The written contract must include:

- The location and the type of work, including the crops to be harvested.
- The time period the work will cover.

Good recordkeeping and communication tools are essential to successful farm business management. Photo by Luke Freeman.

- The wage rates, including any piece rates.
- Any benefits, such as housing or transportation, and the value of the benefit, if any.
- Whether workers' compensation or state unemployment insurance is provided.
- The existence of any employee-initiated work stoppage or slowdown at the worksite.
- Whether the employer or his or her agents will receive any commissions or other benefits from any sales made to the workers.
- Any other working terms or conditions.

Employers must display a poster that describes the rights and protections of workers to comply with the Department of Labor Migrant and Seasonal Worker Protection Act (MSPA).

Aside from the employer's responsibility for the employee's wages, the area of greatest risk to the employer is the risk of liability for employee injuries on the job. By the early 1900s, every state had adopted a workers' compensation law to cover on-the-job injuries. Some of the employer's general duties are to:

Continued education and training can help a farm manager hone skills and stay up-to-date on new production technologies. Photo by Luke Freeman.

- Provide reasonably safe tools.
- Provide a reasonably safe place to work.
- Warn and instruct employees of dangers that the employees could not have been expected to discover.
- Provide reasonably competent fellow employees.

## Insurance

An insurance policy is a legally binding contract between the insurance company and the policyholder (person insured) that specifies that for the exchange of a payment (premium), the insurance company agrees to pay for certain types of loss or damage. The loss is covered when it meets all of the requirements described by the terms of the insurance policy.

### • *Crop Insurance*

Agricultural producers can protect themselves against the loss of their crops (crop-yield insurance) or the loss of revenue (crop-revenue insurance). In the United States, the Risk Management Agency administers a federal insurance program authorized by the Federal Crop Insurance Act. Federal crop insurance is sold and serviced through private insurance companies. Some of the crop insurance plans are: yield protection, revenue protection, and revenue protection with harvest price exclusion. However, these insurance plans are not available in all states and counties. For information on programs available in your state, contact your state department of agriculture, your local conservation district office or your university extension personnel.

The Risk Management Agency (RMA) has a new pilot program that covers the whole-farm revenue. It provides coverage for all commodities on the farm under one insurance policy. This insurance plan includes farms with specialty or organic commodities or those marketing to local, regional, specialty or direct markets.

### • *Liability Insurance*

A liability policy protects a farmer against claims or lawsuits brought by persons whose property or person has allegedly been injured by the farmer's negligence. Whether you need insurance depends on:

- Business activities.
- The amount of liability exposure that you have from the activity.
- Worker's compensation insurance.
- State disability insurance.
- Unemployment insurance.

Liability policies, however, exclude coverage for business pursuits other than farming. It is desirable to seek liability coverage for hunting activities that will occur on your land. A written hunting lease is an essential tool for protecting you and your assets if an accident should occur on your property. Liability policies contain critical exclusions:

- Family members injured by farmer's negligence are excluded.
- Other non-farm employees injured by a farmer's negligence are also routinely excluded from coverage.

## Federal and State Conservation Programs

The USDA provides agricultural producers with technical and financial assistance to help implement conservation practices (to comply with federal, state and local environmental regulations) or test their conservation benefits and effects. Qualified producers can apply voluntarily to implement conservation practices that address natural resource concerns (e.g., to improve soil, water, plant, animal, air and related resources on agricultural land).

- ***Environmental Quality Incentives Program (EQIP)***

The Natural Resources Conservation Service (NRCS) makes available financial assistance payments through EQIP to eligible producers that want to implement approved conservation practices on eligible land.

- ***High Tunnel Initiative (HTI)***

The NRCS also provides financial assistance payments through HTI to help producers extend the growing season for high value crops in an environmentally safe manner.

Interested producers can obtain more information about the EQIP or the HTI through their local NRCS office. Additionally, some states may offer state level conservation assistance. For information on programs available in your state, contact your state department

Farm visits offer the opportunity to learn from other operations. Photo by Luke Freeman.

of agriculture, your local conservation district office or your university extension personnel.

## Estate planning

An estate is the total property, real and personal, owned by an individual prior to distribution through a trust or will. Real property is real estate; personal property includes everything else, such as cars, household items and bank accounts, for example. Estate planning distributes the real and personal property to an individual's heirs. Estate planning is the process by which an individual or family arranges the transfer of assets in anticipation of death. An estate plan aims to preserve the maximum amount of wealth possible for the intended beneficiaries and flexibility for the individual prior to death. When drafting an estate plan, both state and federal law must be consulted to ensure an individual's requests can be carried out within the bounds of those laws.

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# Marketing 13

## Introduction

Marketing is defined as placing the right product in the right place, at the right price, at the right time. Before starting a berry production enterprise, the producer needs to gather important information to identify a market need (e.g., customers want fresh berries), the size of the market and potential competitors. Then the producer needs to figure out how to produce fresh berries at a price that represents value to customers, and bring the berries at the right time to the market, and still make a profit.

In general, there are four different elements of marketing that producers need to take into consideration in the process of bringing fresh berries to the market. Those elements are: product, place, price and promotion. Below are some of the many questions that will help producers understand and define each of those elements:

## Product

- What does the customer want from the product?
- What needs does it satisfy?
- What features does it have to meet these needs?
- How and where will the customer use it?
- How is it branded?
- How is it differentiated from the competitors' products?

## Place

- Where do buyers look for berries? (e.g., organic store, supermarket, online, farmers market, at the farm)
- How can producers access the right distribution channels?
- Do producers need to attend trade fairs or send samples to supermarkets or potential buyers?
- What do competitors do? How can producers learn from that and/or differentiate?

## Price

- What is the value of the product to the buyer?


Clear signage and unique branding will help attract customers. Photo by Luke Freeman.

- Are there established price points for products in the area?
- Is the customer price sensitive? Will a small decrease in price gain the producer extra market share? Will a small increase in price gain the producer extra profit margin?
- What discounts should be offered to trade customers?
- How will price compare with those of the competition?

The selling price can also be determined by any of the following four alternatives:

- Cost basis — pricing to cover your total cost of production (only).
- Follow the leader — pricing according to other competitors.
- Trial and error — set price and see how consumers respond.
- Loss leader — pricing cheaper than competitors to get consumers.

## Promotion

- Where and when can the producer get across marketing messages to the target market?
- Will customers be reached by advertising in the press, radio, flyers, on the internet, etc.?


McGarrah Farm markets berries through direct sales and pick-your-own. Photo by Luke Freeman.

- When is the best time to promote? Is there seasonality in the market?
- How do competitors do their promotions? How does that influence the choice of promotional activities?

Once the four elements are well defined, ask yourself customer-focused questions:

- Product — Does it meet customers' needs?
- Place — Will customers find it where they shop?
- Price — Will customers consider the price favorably?
- Promotion — Will the marketing communications reach customers?

## Marketing Options

The producer can sell the fruit directly to consumers (direct market) or through others (wholesale/retail). Berry fruits are very perishable and therefore require immediate sale. The price the producer will receive by selling in the fresh market will depend on many factors, but greatly on quality. Small producers can increase their net returns by direct marketing high-quality berries. There are many marketing options but the two general market categories are: 1) fresh market and 2) processed market.

### • *Fresh Market*

**Pick-Your-Own (PYO)** is a marketing strategy that may be highly attractive as a low-investment alternative. Labor costs are much lower for PYO operations because workers are not needed for harvest; however, producers that choose this option are opening the farm to the public and this has commercial and legal implications. Producers must buy liability insurance. This insurance can be costly and difficult to acquire in some locations.

For a PYO operation to be successful, the farm must be located close to a densely populated area. The farm must provide a parking area, picking containers and bathrooms among other services. Additionally, the producer must have the marketing skills to promote and inform potential customers about the operation and its products. The producer must have the management and organizational skills to keep track of input expenses and maintain yield records as well as the personal skills necessary to provide an inviting environment for the customers. Even if the producer possesses all of these skills, weather can have a negative effect on this marketing strategy.

**Farmers' markets** serve as a venue for producers to sell their produce directly to consumers. Like PYO, they provided an opportunity to meet and interact with customers on a regular basis. The producer can select from a number of local and regional markets. Usually, the producer must become a member of the farmers' market and fulfill some requirements and responsibilities. There are specific selling rules, space assignments, hours, days, and months of operation. Understanding the rules before becoming a member of a particular farmers' market is crucial. Prices should be fair for both the producer and the customer. Knowing how much it costs to produce berries will help determine a price that generates a good return.

**Wholesale** markets usually include retailers, such as supermarket or warehouse chains, food manufacturers, and restaurants or institutions that need relatively large quantities of fruit. These buyers must be

contacted in advance to set up prices and quantities, and to specify container or packaging preferences (if any) and delivery schedules. Producers may need to invest in packing, storage and transportation facilities. The producer may need to become a member of a cooperative to meet the needs of large buyers.

### • *Processed Market*

Berries are very fragile, and improper handing during or after harvest can make the berries unsuitable for the fresh market. Berries may therefore be better suited for sale in the processed market where value can be added to the product so it can be sold in processed forms. It should be noted, however, that there are more government regulations for some types of processed foods than for fresh foods. Producers must follow appropriate state and federal sanitation, processing and labeling regulations if they choose to sell processed berries.

Selling frozen berries is a good way to market berries not suitable for, or in excess demand of, the fresh market. To avoid losing flavor, freezing should occur rapidly after harvest. In some states freezing is not considered processing, so it is important to contact the appropriate health authorities before freezing berries for later sale. While it is not recommended to rely entirely on culls for value-added products, culls can make up a large part of fruit ingredients in products such as jams and jellies. These products provide the advantage of having a year-round product to sell directly to consumers or through wholesalers.

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# Appendix of Resources

## General Blackberry and Raspberry Resources

- **North Carolina State Team Rubus blog**, http://teamrubus.blogspot.com/
- **North Carolina Blackberry and Raspberry Growers Information Portal**, http://rubus.ces.ncsu.edu/
- **Southern Region Small Fruit Consortium**, http://www.smallfruits.org/

## 1. Site Selection

### *Web Links:*

- **2008 Southeast Regional Bramble Production Guide**, G. Fernandez and G. Krewer. Small Fruit Consortium. http://www.smallfruits.org/smallfruitsregguide/Guides/2008/08BrambleguideMay22.pdf
- **Commercial Bramble Culture**, G. Krewer, B. Smith, P. Brannen and D. Horton. Univ. of Georgia Agr. Expt. Sta. Bul. 964. http://www.smallfruits.org/Bramble/production/BRAMBLE.pdf
- **Growing Blackberries in Missouri**, G. Ames and P.L. Byers. State Fruit Expt. Sta. of Southwest Missouri State Univ. http://mtngrv.missouristate.edu/assets/publications/b39growingblackberriesinmissouri.pdf
- **Growing Blackberries in North Carolina**, G. Fernandez and J.R. Ballington. North Carolina Coop. Ext. Serv. AG-401. http://content.ces.ncsu.edu/growing-blackberries-in-north-carolina.pdf
- **Growing Raspberries in North Carolina**, G. E. Fernandez, F.J. Louws, J.R. Ballington, and E.B. Poling. North Carolina Coop. Ext. Serv. AG-569. http://www.ces.ncsu.edu/depts/hort/hil/ag569.html

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- Bushway, L., M. Pritts and D. Handley. **Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada**. Natural Resource, Agr., and Eng. Serv. NRAES-35.

## 2. Site Preparation

### *Web Links:*

- **Careful Soil Sampling: The Key to Reliable Soil Test Information**, J.V. Baird, S.C. Hodges and M.R. Tucker. North Carolina Coop. Ext. Serv. AG-439-30. http://content.ces.ncsu.edu/careful-soil-sampling-the-key-to-reliable-soil-test-information.pdf
- **Cover Crops with Biofumigation Properties for the Suppression of Plant-Parasitic Nematodes: A Review**, D.H.M. Kruger, J.C. Fourie and A.P. Malan. S. Afr. J. Enol. Vitic., Vol. 34, No. 2. http://www.sasev.org/journal/list-of-journals/cover-crops-with-biofumigation-properties-for-the-suppression-of-plant-parasitic-nematodes-a-review/?id=14&entryId=202
- **Midwest Small Fruit Pest Management Handbook**, R. Funt, M. Ellis and C. Welty. Ohio State Univ. Ext. Bul. 861. http://pested.osu.edu/documents/CommStudy/2b%20Midwest%20Small%20Fruit%20Pest%20Mgmt..pdf
- **Understanding the Numbers on Your Soil Test Report**, L. Espinoza, N. Slaton and M. Mozaffari. Univ. of Arkansas System Div. of Agr. FSA2118. http://www.uaex.edu/publications/PDF/FSA-2118.pdf

## 3. Soil and Nutrient Management

### *Web Links:*

- **Careful Soil Sampling: The Key to Reliable Soil Test Information**, J.V. Baird, S.C. Hodges and M.R. Tucker. North Carolina Coop. Ext. Serv. AG-439-30. http://content.ces.ncsu.edu/careful-soil-sampling-the-key-to-reliable-soil-test-information.pdf
- **Foliar Sampling for Fruit Crops**, M.E. Garcia. Univ. of Arkansas System Div. of Agr. FSA6132. http://www.uaex.edu/publications/pdf/FSA-6132.pdf
- **Understanding the Numbers on Your Soil Test Report**, L. Espinoza, N. Slaton and M. Mozaffari. Univ. of Arkansas System Div. of Agr. FSA2118. http://www.uaex.edu/publications/PDF/FSA-2118.pdf

## 4. Plant Selection

### *Web Links:*

- **Licensed Propagators for University of Arkansas Patented Blackberry Cultivars**. Univ. of Ark. Ext. http://www.uaex.edu/farm-ranch/crops-commercial-horticulture/horticulture/docs/CommHort_blackberries-Licensed-Propagators-UofA-Patent.pdf
- **Small Fruit Cultivar Recommendations for Arkansas**, M. Elena Garcia and J. Clark. Univ. of Ark. Ext. http://www.uaex.edu/publications/PDF/FSA-6130.pdf

## 5. Water Management and Irrigation

### *Web Links:*

- **Growing Raspberries in Wisconsin**, B.R Smith, T.R. Roper and P.S. McManus. Univ. of Wisconsin Ext. http://learningstore.uwex.edu/assets/pdfs/A1610.PDF
- **Pest Management of Blackberries**, D. Johnson. Blackberry Production Wkshp. at Fruit Sta. at Clarksville, AR. http://comp.uark.edu/~dtjohnso/Blackberry_PM_Workshop_23_Jun_11.pdf
- **Using tensiometers for measuring soil water and scheduling irrigation**, D. Hensley and J. Deputy. http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/L-10.pdf

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- **Growing Raspberries in Wisconsin**, B.R Smith, T.R. Roper, P.S. McManus. Univ. of Wisconsin Ext. http://polk.uwex.edu/files/2014/02/Growing-Raspberry-in-WI-A1610.pdf

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- Takeda, F., and D.L. Peterson. 1999. **Considerations for Machine Harvesting Fresh-Market Eastern Thornless Blackberries: Trellis Design, Cane Training Systems, and Mechanical Harvester Development.** HortTechnology 9(1).

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### *Publications:*

- Gleason, M., D. Lewis and J. Hartman. 1997. **Small fruits: insect and disease management for backyard fruit growers in the Midwest (IDEA)**. Iowa State Univ.
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- **Pasture Weed Control in Arkansas**, J. Boyd and B. Griffin. Univ. of Ark. Ext. MP522. http://www.uaex.edu/publications/pdf/mp522.pdf
- **Weed Control Commercial and Non-Commercial Applicator Training Manual**, J. Boyd and J.D. Hopkins. Univ. of Ark. Ext. MP446-PD-5-04N http://www.uaex.edu/farm-ranch/pest-management/docs/training-manuals/AG1160.pdf

### *Publications:*

- **Managing Cover Crops Profitably**. 1998. Sustainable Agriculture Network. 2nd ed. Natl. Agr. Library. Beltsville, MD.

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### *Web Links:*

- **Blackberry Certification Program**, Z. Pesic-VanEsbroeck, G. Fernandez, T. Guzman and M. Fountain. North Carolina State Univ. http://www.smallfruits.org/BrambleAgentTraining05/presentations/Pesic.pdf
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### *Web Links:*

- **Arkansas Groundwater Protection and Management Report for 2013**. Arkansas Natural Resources Commission. https://static.ark.org/eeuploads/anrc/2013-2014AnnualReport.pdf
- **Coping with Slips, Trips, and Falls in Farming Enterprises**, J. LaPrade. Alabama Coop. Ext. System. ANR-1269. http://www.aces.edu/pubs/docs/A/ANR-1269/ANR-1269.pdf
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## 11. Harvest, Post-Harvest and Food Safety

### *Web Links:*

- **Blackberry & Raspberry Information — Postharvest.** North Carolina Coop. Ext. http://rubus.ces.ncsu.edu/rubus-postharvest/
- **Can raspberries be picked pink for fresh markets?** P. Perkins-Veazie. Blogpost Sept 19, 2011. http://teamrubus.blogspot.com/2011/09/can-raspberries-be-picked-pink.html
- **Hand-Washing Units Summary,** P. Perkins-Veazie, G. Fernandez, D. Ducharme, L. Wojciechowski, and J. Moore. N. C. State Univ., Plants for Human Health Inst. http://www.smallfruits.org/CoAgentTraining/Posthavest2012/07a%20Hand-washing%20unit%20one-pager.pdf
- **Pack N' Cool and Cold Storage**, North Carolina State Plants for Human Health Institute, https://www.youtube.com/watch?v=gI4ieFRvB04
- **Postharvest Handling and Storage of Blackberries and Raspberries.** P. Perkins-Veazie. Small Fruit Nwsl., The Small Fruit Consortium, 10(2). http://rubus.ces.ncsu.edu/rubus-postharvest-handling-and-storage-of-blackberries-and-raspberies/
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- **Postharvest handling and transportation of fruits and vegetables.** G.E. Boyhan, W.C. Hurst, W.T Kelley, G.W. Krewer and K.C. Taylor. Univ. of Georgia Coop. Ext. http://www.fruit.cornell.edu/berry/postharvest/postharvestpdfs/FS100.pdf
- **Production Guide for Storage of Organic Fruits and Vegetables.** C.B. Watkins and J.F. Noak. Cornell Univ., NYS IPM Publ. No. 10. http://nysipm.cornell.edu/organic_guide/stored_fruit_veg.pdf

### *Publications:*

- Galeletta G.J. and D.G Himelrick, (eds.) 1989. **Small Fruit Crop Management.** Prentice Hall Career & Technology, Englewood Cliffs, NJ

### *GAP and Food Safety Resources Online:*

- **California Strawberry Commission Food Safety Program**, http://caff.org/wp-content/uploads/2012/06/Strawberry-GAPs-FSP_English.pdf
- **Food Safety Begins on the Farm. A Growers Guide.** http://www.gaps.cornell.edu/documents/edumat/FSBFEngLOW.pdf
- **Good Agricultural Practices A Self-Audit for Growers and Handlers**, http://onfarmfoodsafety.org/wp-content/uploads/ucdavis-food-safety-audit.pdf
- **Good Agricultural Practices for the Production and Handling of Strawberry, Raspberry, Blackberry and Blueberry**, http://fbns.ncsu.edu/extension_program/documents/GAP_berries.pdf
- **Good Food Network, Food Safety Resource**, http://www.ngfn.org/resources/ngfn-cluster-calls/food-safety
- **Hand Hygiene for Farm Management**, http://norocore.ncsu.edu/wordpress/wp-content/uploads/2014/04/berry-for-mgmt.pdf
- **Hand Washing Unit Summary**, http://www.smallfruits.org/CoAgentTraining/Posthavest2012/07a%20Hand-washing%20unit%20one-pager.pdf
- **Harvester's Keeping Your Hands Clean**, http://norocore.ncsu.edu/wordpress/wp-content/uploads/2014/04/berry-workers.pdf
- **How to build a field hand washing station in 10 easy steps for under $20**, University of Minnesota Agriculture Health and Safety Program, http://safety.cfans.umn.edu/files/2011/12/Handwashing_station_instructions.pdf
- **N.C. Fresh Produce Safety**, http://ncfreshproducesafety.ces.ncsu.edu/
- **The National GAP Program**, http://www.gaps.cornell.edu/
- **The Produce Safety Alliance**, http://producesafetyalliance.cornell.edu/

## 12. Business Management

### *Web Links:*

- **Arkansas NRCS Conservation Programs, United States Department of Agriculture — Natural Resources Conservation Service**. http://www.nrcs.usda.gov/wps/portal/nrcs/main/ar/programs/
- **Center for Agricultural and Rural Sustainability.** http://cars.uark.edu/
- **Cultivating compliance: An agricultural guide to federal labor law. United States Department of Labor.** http://www.dol.gov/whd/FLSAEmployeeCard/AgGuideEnglish.pdf
- **EQIP Seasonal High Tunnel Initiative, United States Department of Agriculture — Natural Resources Conservation Service.** http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/?cid=stelprdb1046250
- **Farm structure and organization.** R. Hoppe and D. Newton. U.S. Dept. of Agr., Economic Res. Serv. http://www.ers.usda.gov/topics/farm-economy/farm-structure-and-organization.aspx
- **Federal Crop Insurance: A Program Update (2011)**, W.J. Murphy. http://www.rma.usda.gov/news/2011/02/murphycirb.pdf
- **Risk Management Guide: Managing business, financial and legal risks**. J. Popp, H.G. Rodriguez and K. McGraw. http://cars.uark.edu/ourwork/Complete%202011%20RMA%20Guide.pdf
- **Whole-Farm Revenue Protection Pilot Program (WFRP). United States Department of Agriculture — Risk Management Agency.** http://www.rma.usda.gov/policies/wfrp.html

## 13. Marketing

### *Web Links:*

- **Farmers Markets and Local Food Marketing.** United States Department of Agriculture — Agricultural Marketing Service. http://www.ams.usda.gov/services/local-regional
- **Farmers' Markets Marketing and Business Guide.** J. Bachmann. ATTRA Publication. Natl. Sustainable Agr. Info. Serv. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=265
- **Master publication list. National Sustainable Agriculture Information Service.** https://attra.ncat.org/publication.html#marketing
- **Risk Management Guide: Managing business, financial and legal risks.** J. Popp, H.G. Rodriguez and K. McGraw. http://cars.uark.edu/ourwork/Complete%202011%20RMA%20Guide.pdf

### *Publications:*

- National Center for Appropriate Technology. 2014. **NCAT Marketing Tip Sheet Series.**

# Notes

# Sustainable Blackberries & Raspberries
# Self-Assessment Checklist

See "Checklist Explained" on page 65 for more detail on checklist categories.

| 1. SITE SELECTION | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Soil type | ☐ | ☐ | ☐ |
| B) Native fertility | ☐ | ☐ | ☐ |
| C) Air drainage | ☐ | ☐ | ☐ |
| D) Wind protection | ☐ | ☐ | ☐ |
| E) Sun exposure | ☐ | ☐ | ☐ |
| F) Cropping history | ☐ | ☐ | ☐ |
| G) Isolation from wild brambles | ☐ | ☐ | ☐ |
| H) Water availability | ☐ | ☐ | ☐ |
| I) Slope | ☐ | ☐ | ☐ |
| J) Other _____ | ☐ | ☐ | ☐ |

| 2. SITE PREPARATION | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Site clearing | ☐ | ☐ | ☐ |
| B) Perennial weeds eliminated | ☐ | ☐ | ☐ |
| C) Nematodes controlled if present | ☐ | ☐ | ☐ |
| D) Soil modified to allow for drainage | ☐ | ☐ | ☐ |
| E) Soil amended based on soil test | ☐ | ☐ | ☐ |
| F) Organic matter added | ☐ | ☐ | ☐ |
| G) Perennial ground cover established in row middles | ☐ | ☐ | ☐ |
| H) Other _____ | ☐ | ☐ | ☐ |

| 3. SOIL AND NUTRIENT MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Soil tests | ☐ | ☐ | ☐ |
| B) Foliar analysis | ☐ | ☐ | ☐ |
| C) Nitrogen application | ☐ | ☐ | ☐ |
| D) Fertilizer application method | ☐ | ☐ | ☐ |
| E) Mulched rows | ☐ | ☐ | ☐ |
| F) Ground cover in row middles | ☐ | ☐ | ☐ |
| G) Other _____ | ☐ | ☐ | ☐ |

| 4. PLANT SELECTION | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Cultivar selection | ☐ | ☐ | ☐ |
| B) Plant quality and virus free plants | ☐ | ☐ | ☐ |
| C) Other _____ | ☐ | ☐ | ☐ |

| 5. WATER MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Water source | ☐ | ☐ | ☐ |
| B) Soil moisture monitoring | ☐ | ☐ | ☐ |
| C) I rrigation system | ☐ | ☐ | ☐ |
| D) Routine maintenance of irrigation system | ☐ | ☐ | ☐ |
| E) Record of water usage | ☐ | ☐ | ☐ |
| F) Mulch to preserve moisture | ☐ | ☐ | ☐ |
| G) Other _____ | ☐ | ☐ | ☐ |

| 6. TRELLISING AND PRUNING | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Cane support | ☐ | ☐ | ☐ |
| B) Pruning/training | ☐ | ☐ | ☐ |
| C) Ease of harvest | ☐ | ☐ | ☐ |
| D) Other _____ | ☐ | ☐ | ☐ |

| 7. INSECT AND MITE MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Recognize pests and pest damage | ☐ | ☐ | ☐ |
| B) Know pest phenology | ☐ | ☐ | ☐ |
| C) Monitor for pest presence | ☐ | ☐ | ☐ |
| D) Make pest management decisions based on monitoring | ☐ | ☐ | ☐ |
| E) Know vulnerable pest stage | ☐ | ☐ | ☐ |
| F) Use appropriate pest control tactic | ☐ | ☐ | ☐ |
| G) Select pesticide that conserves natural enemies | ☐ | ☐ | ☐ |
| H) Rotate modes of action (resistance management) | ☐ | ☐ | ☐ |
| I) Evaluate effectiveness of tactic | ☐ | ☐ | ☐ |
| J) Attend yearly fruit workshops | ☐ | ☐ | ☐ |
| K) Other _____ | ☐ | ☐ | ☐ |

| 8. WEED MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Use of mulch | ☐ | ☐ | ☐ |
| B) Cover crops for weed control | ☐ | ☐ | ☐ |
| C) Cultivation | ☐ | ☐ | ☐ |
| D) Herbicides | ☐ | ☐ | ☐ |
| E) Other _____ | ☐ | ☐ | ☐ |

| 9. DISEASE AND VIRUS MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Use of virus-free plants | ☐ | ☐ | ☐ |
| B) Site testing | ☐ | ☐ | ☐ |
| C) Sanitation | ☐ | ☐ | ☐ |
| D) Pruning for air circulation | ☐ | ☐ | ☐ |
| E) Irrigation | ☐ | ☐ | ☐ |
| F) Vector control | ☐ | ☐ | ☐ |
| G) Other _____ | ☐ | ☐ | ☐ |

| 10. FARM SAFETY | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Tool and equipment safety | ☐ | ☐ | ☐ |
| B) Employee safety training | ☐ | ☐ | ☐ |
| C) Employee personal safety | ☐ | ☐ | ☐ |
| D) Fertilizer storage | ☐ | ☐ | ☐ |
| E) Pesticides storage | ☐ | ☐ | ☐ |
| F) Other _____ | ☐ | ☐ | ☐ |

| 11. HARVEST, POST-HARVEST AND FOOD SAFETY | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Frequency and timing of harvest | ☐ | ☐ | ☐ |
| B) Harvest containers | ☐ | ☐ | ☐ |
| C) Berry quality | ☐ | ☐ | ☐ |
| D) Culled berries removed | ☐ | ☐ | ☐ |
| E) Post-harvest handling | ☐ | ☐ | ☐ |
| F) Cold storage conditions | ☐ | ☐ | ☐ |
| G) Other _____ | ☐ | ☐ | ☐ |

| 12. BUSINESS MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Farm business structure | ☐ | ☐ | ☐ |
| B) Farm business management | ☐ | ☐ | ☐ |
| C) Labor issues | ☐ | ☐ | ☐ |
| D) Crop insurance | ☐ | ☐ | ☐ |
| E) Liability insurance | ☐ | ☐ | ☐ |
| F) Participate in USDA conservation programs | ☐ | ☐ | ☐ |
| G) Estate planning | ☐ | ☐ | ☐ |
| H) Other _____ | ☐ | ☐ | ☐ |

| 13. MARKETING | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Product | ☐ | ☐ | ☐ |
| B) Location | ☐ | ☐ | ☐ |
| C) Price | ☐ | ☐ | ☐ |
| D) Promotion | ☐ | ☐ | ☐ |
| E) Marketing options | ☐ | ☐ | ☐ |
| F) Other _____ | ☐ | ☐ | ☐ |

## SUMMARY

| For each of the previous categories, summarize the number of checks in each rating class. | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| 1. Site Selection | _____ | _____ | _____ |
| 2. Site Preparation | _____ | _____ | _____ |
| 3. Soil and Nutrient Management | _____ | _____ | _____ |
| 4. Plant Selection | _____ | _____ | _____ |
| 5. Water Management | _____ | _____ | _____ |
| 6. Pruning and Trellising | _____ | _____ | _____ |
| 7. Insect and Mite Management | _____ | _____ | _____ |
| 8. Weed Management | _____ | _____ | _____ |
| 9. Disease and Virus Management | _____ | _____ | _____ |
| 10. Farm Safety | _____ | _____ | _____ |
| 11. Harvest | _____ | _____ | _____ |
| 12. Business Management | _____ | _____ | _____ |
| 13. Marketing | _____ | _____ | _____ |
| **OVERALL TOTALS**<br>Summarize the totals of the above for each column. | _____ | _____ | _____ |
| **OVERALL TOTALS**<br>**from previous year**<br>List the totals for each column from the previous year's evaluation | _____ | _____ | _____ |
| **Year-to-Year Change**<br>Subtract last year's totals from current year to evaluate change between years. A positive number in Excellent categroy indicates preogress, and a positive number in the Needs Improvement category indicates areas of weekness. | _____ | _____ | _____ |

# Plan for Sustainability

From the evaluation of your checklist, indicate the following:

## Areas of Strength

List and discuss those areas of management and operation where you demonstrate satisfactory or excellent performance.

## Areas for Improvement

List and discuss those areas of management and operation where you need improvement in performance.

## Plan for Increasing Sustainability

Based upon your own evaluation of strength and areas where you need to improve, list steps you plan to take and/or procedures you plan to implement in the coming year to increase your farm sustainability.

# Notes

## Sustainable Blackberries & Raspberries

# Checklist Explained

| 1. SITE SELECTION | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Soil type | Soil is poorly drained OR does not retain moisture OR has low organic matter content. | Soil has most, but not all of the characteristics of an ideal soil. | Soil is a sandy loam or loam with 2-4% organic matter, good drainage and moisture retention. |
| B) Native fertility | Soil is deficient in several nutrient categories OR has a pH that is outside of the desired range. | Soil contains adequate levels of most nutrients, along with proper CEC and pH. | 50-100 lbs P/ac, 250-300 lbs K/ac, and 150-200 lbs Mg/ac with a CEC of 8 to 16 meq/100g and a pH of 6.0-6.5. |
| C) Air drainage | Site is in a low-lying area or is surrounded by wind-blocks that restrict air movement and subject site to frost damage. | Air movement is restricted somewhat or slope is not ideal. | Site is elevated or has a gentle slope of 2-3% to allow for drainage of cold air and protection from frost. |
| D) Wind protection | Site is subject to strong winds that cause cane breakage or fruit desiccation. | Site is subject to infrequent wind damage. | Site is protected from damaging or desiccating winds, but there is still sufficient air movement. |
| E) Sun exposure | Site is exposed to partial sun OR site is on a south-facing slope that increases risk of winter injury. | | Site is exposed to full sun and is not on a south-facing slope. |
| F) Cropping history | Solanaceous crops, strawberries or bramble fruits have been grown on site within 5 years. | No solanaceous crops, strawberries or bramble fruits have been grown on site for 5 years. | No solanaceous crops, strawberries or bramble fruits have ever been grown on site. |
| G) Isolation from wild brambles | Wild brambles are within 350 feet of site. | Wild brambles are at least 350 feet away from site. | There are no wild brambles within 1/4 mile of site. |
| H) Water availability | Site does not have affordable water access. | Site has access to surface water or affordable rural water utilities. | Site has well access or other inexpensive high-quality water source. |
| I) Slope | Slope is greater than 3% and poses erosion risk OR site is level and does not allow for air and water drainage. | Site is level, but elevation allows for air and water drainage. | Site has gentle slope of 2-3% to allow for air and water drainage. |

| 2. SITE PREPARATION | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Site clearing | Woody plants, wild blackberries or debris remain on site. | | Site is cleared of all woody plants, stumps, large roots and wild blackberries. |
| B) Perennial weeds eliminated | Perennial weeds remain and there is no management strategy in place. | Some perennial weeds remain, but there is a management strategy in place to eliminate weeds after planting . | All perennial weeds are eliminated from site prior to planting. |
| C) Nematodes controlled if present | Pest nematodes were detected, but not controlled. | Pest nematodes were detected and controlled through chemical fumigation. | Pest nematodes were not present on site OR nematodes were effectively controlled through biofumigation or solarization. |
| D) Soil modified for drainage | Soil has poor drainage and no action was taken. | Soil was subsoiled, but drainage is still not optimal. | Soil has naturally sufficient drainage OR subsoiling OR drainage tile was used to improve drainage. |
| E) Soil amended based on soil test | No soil test was taken and soil nutrient status is still unknown. | Soil test was taken, but nutrient deficiencies still exist. | Soil test was taken and soil pH and nutrient status was modified to be optimal for bramble production. |
| F) Organic matter added | No organic matter was added to site. | Organic matter was added to site, but soil organic matter is still less than 2%. | 10-20 tons of organic matter per acre were added in the form of animal manure, compost or green manure. |
| G) Perennial ground cover established in row middles | No ground cover was established. | Row middles will be maintained with annual cover crops or mulch. | A perennial ground cover of fescue or perennial ryegrass was established in row middles prior to blackberry planting. |

| 3. SOIL AND NUTRIENT MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Soil tests | No soil tests have been taken, but lime and/or nutrients are applied to the site without knowledge of appropriate amount. | A soil test was taken during site preparation and amendments were added based on test, but current state of soil is unknown. | Soil tests are taken at least every 3 years and soil amendments are applied based on soil test results. |
| B) Foliar analysis | No foliar analyses have been taken. | Nutrients are applied based on observation of blackberry plants, but no foliar analyses are taken. | Foliar analyses are taken at least every other year and results are used to determine foliar and soil nutrient applications. |
| C) Nitrogen application | Nitrogen is applied in excessive amounts that result in environmental contamination or food safety risk OR yield suffers from insufficient nitrogen. | Nitrogen is applied to meet crop needs, but consideration is not given to food safety or environmental concerns. | Nitrogen is applied from a sustainable source and in a way that minimizes food safety risks, runoff and groundwater contamination. |

| | | | |
|---|---|---|---|
| D) Fertilizer application method | Fertilizers are applied to the soil surface in excessive amounts and in conditions that create the potential for runoff. | Fertilizers are applied in appropriate amounts, but no care is taken to minimize runoff or avoid environmental contamination. | Fertilizers are applied as needed and in ways that minimize runoff (e.g. fertigation or foliar sprays). |
| E) Mulched rows | Vegetation is allowed to grow within the rows, competing with brambles for nutrients and moisture. | Rows are not mulched, but maintained free of weeds. | Rows are mulched with an organic material that suppresses weeds and preserves soil moisture. |
| F) Ground cover in row middles | There is no ground cover in row middles, exposing bare soil to erosion risk. | Row middles are maintained with annual cover crops or native vegetation. | A non-competitive perennial ground cover is maintained in row middles. |

| **4. PLANT SELECTION** | **NEEDS IMPROVEMENT** | **SATISFACTORY** | **EXCELLENT** |
|---|---|---|---|
| A) Cultivar selection | Cultivar or characteristics of plants are unknown or undesirable. | Plant characteristics are known but might not be the best selection for production area. | Plants are selected for characteristics that optimize production for the area, including yield, disease resistance, bloom & harvest dates, and fruit shelf life. |
| B) Plant quality | New material is obtained/ propagated from plants already in production, and unknown diseases or viruses may be passed on. | Plant source is trustworthy, but does not guarantee that material is free of disease or viruses. | Plant material is from a trustworthy source that guarantees disease free stock and provides certified of virus free plants. |

| **5. WATER MANAGEMENT** | **NEEDS IMPROVEMENT** | **SATISFACTORY** | **EXCELLENT** |
|---|---|---|---|
| A) Water source | Water source is expensive, in limited supply or non-existent. | Water source is economical, but contains high mineral content or particulate matter which requires frequent flushing of lines. | Water source is economical and high-quality; regularly tested; filtered before use. |
| B) Soil moisture monitoring | Water is applied when plants appear water stressed OR no irrigation system is installed. | Irrigation is run on a regular basis regardless of soil moisture level or apparent plant water stress. | Soil moisture sensors in each block measure daily changes in soil moisture; trickle irrigation is monitored to maintain soil moisture at or below 30 kPa. |
| C) Irrigation system | Overhead sprinkler system is used for irrigation. | Basic drip irrigation system with backflow prevention, but no fertigation ability. | Professionally engineered and installed drip irrigation system with backflow prevention, pressure compensating emitters and fertigation capability. |

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| D) Routine maintenance of irrigation system | No system maintenance is performed. | Irrigation system is only checked and repaired when serious leaks are noticed. | System components checked at start of season, and line inspected for leaks and clogged emitters during each irrigation session. |
| E) Record of water usage | No flow meter is used while irrigating, so water use is unknown. | Irrigation water use is determined by flow meter but records are not kept. | Irrigation water use is determined by flow meter and records are kept by block. |
| F) Mulch to preserve moisture | Soil is bare in the row. | | Mulch (organic or inorganic) covers soil within the row to preserve soil moisture. |

| **6. TRELLISING AND PRUNING** | **NEEDS IMPROVEMENT** | **SATISFACTORY** | **EXCELLENT** |
|---|---|---|---|
| A) Cane support | No trellis system, or current system is too minimal. Posts weather over time, and wire is sagging under the weight of the crop. Unsupported branches are a tangled mess that grow into the aisles and break under weight of fruiting. | Trellis is simple, but sufficient to support the weight of the crop. Canes may be disorganized, but wire is thick/strong enough to minimize sprawl. | Wire gauge holds the weight of the crop without yielding. Posts are durable and maintain wire tension. Trellis system supports branches, preventing fruit-laden canes from breaking. Rows are narrow and primocanes and floricanes are kept separate. Only one side needs to be accessed for harvest. |
| B) Pruning and training | Canes are not spread out and are disorganized. Low light penetration into canopy due to close spacing. Primocanes are forced to grow into the aisles. | Canes are tied and primocanes tipped as they grow over the wire, but space in between is not optimal. Some canes grow across each other, and light/air penetration to inner canopy is low. | Canes are tied to the wires and spaced so as to not interfere with each other. Lateral growth is increased by tipping (blackberry only). Dead canes are removed immediately. Excess canes are removed, allowing light and air to penetrate the innermost regions. Aisles are clear of canes. |
| C) Ease of harvest | Fruit is difficult to access, and pickers must climb under/into the bramble. Harvested product is dirty and irregularly sized. Overall yields and quality are low due to disease and low light penetration. | Most of the fruit grows along the outer canopy, but pickers still have to access the inner canopy for some fruit. Harvested fruit is clean, mostly undamaged, and of decent quality. | Fruiting canopy is maximized and unobstructed. Minimal canopy manipulation is needed — fruit is easily accessed by pickers. The harvested product is clean, undamaged, and a good quality. Yields are high. |

| 7. INSECT AND MITE MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Recognize pests and pest damage | No one can identify the major insect/mite pests or damage and symptoms each causes. | Manager can identify major insect/mite pests, but workers consult posted photo fact sheets. | Manager and workers can identify pest and damage and know where on plant to locate the various growth stages of the major insect/mite pests. |
| B) Know pest phenology | No one knows the biology and phenology of the major insect/mite pests. | Manager knows the biology and phenology of each major insect/mite pest. | Manager and workers know seasonal biology and phenology of each major insect/mite pest. |
| C) Monitor for pest presence | No one monitors for any of the major insect/mite pests. | Manager uses accepted monitoring protocol for each major insect/mite pest, but does not keep monitoring records. | Manager and workers use a season-long monitoring protocol based on pest biology and know which cultivars to sample for each major insect/mite pest, assess damage and keep written records by block/cultivar sampled. |
| D) Make management decisions based on monitoring | Pesticides applied on a calendar schedule to control major insect/mite pests; no spray records kept. | Manager follows monitoring protocol for some of the major insect/mite pests to improve timing of pestcide applications and keeps records of what pesticides were applied. | Manager bases pest management decisions for all the major insect/mite pests on findings from season-long monitoring protocol and action thresholds (e.g. > 5 mites per leaflet; mostly immature stink bugs present) and use suggested record keeping form noting what/when/where each management tactic was used against what pest. |
| E) Know vulnerable pest stage | No one is sure what stage they are trying to time management tactic against. | Manager knows the vulnerable stage of each insect/mite pest to direct pest management tactic(s) against. | Manager knows the vulnerable stage of each insect/mite pest to direct pest management tactic(s) against: larvae of raspberry crown borers at base of canes in early-November; adult and newly hatched larva of rednecked cane borer on primocanes in May and June; all stages of mites on leaves all season; immature stink bugs on fruit; and adult Japanese beetles and green June beetles on fruit or leaves in June and July; and SWD on fruit from mid-June through harvest. |
| F) Use appropriate pest control tactic | Manager is aware of one or two pesticides to control major insect/mite pests. | Manager is aware of the pesticides recommended for most of the major insect/mite pests and some culture practices that reduce pest numbers. | Manager integrates one or more pest management tactics to minimize outbreaks of major insect/mite pests and has calculated the pest management program that is most cost effective over time. |

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| G) Select pesticide that conserves natural enemies | Apply only the recommended broad-spectrum pesticides. | Experienced secondary pest outbreaks after applying broadspectrum pesticides, so have other pesticides available for secondary pest outbreaks. | Use recommended pesticides that target specific insect/mite pest in order to conserve natural enemies of secondary pests. |
| H) Rotate modes of action | Manager is not aware that pests will develop resistance to same pesticide used repeatedly. | Manager is aware that pests have developed resistance to some pesticides and shifts to formulations with different mode of action. | Manager has a seasonal plan that rotates pesticides with different modes of action in order to delay development of resistance in pests. |
| I) Evaluates effectiveness of pest management tactic | Manager applies pesticide every 10 to 14 days, but does not determine efficacy of each application. | Manager calibrates sprayer, uses spray cards to ensure adequate coverage and monitors for outbreaks of major pest. | Manager and workers calibrate sprayer, use spray cards to ensure adequate coverage, evaluate effectiveness of pest management tactic, monitor for major and secondary pest outbreaks and keep records of efficacy by cultivar/block to aid future pesticide purchases or need to implement another tactic. |
| J) Attends yearly fruit workshops | No one attends yearly fruit workshops or grower meetings. | Manager attends yearly fruit workshops and grower meetings but does not consider implementing new pest management practices. | Manager and workers attend fruit workshops and grower meetings when available, develop plan to implement promising pest management tactics, participate in grower discussions of effective practices and help prioritize fruit research and extension needs. |

| **8. WEED MANAGEMENT** | **NEEDS IMPROVEMENT** | **SATISFACTORY** | **EXCELLENT** |
|---|---|---|---|
| A) Use of mulch | No mulch is applied and soil is bare within rows. | Mulch allows for some weed penetration, but suppresses annual weeds for the most part. | Wood-based mulch is relatively weed-free, application is thick enough to suppress annual weeds OR Synthetic mulch is thick and durable enough to suppress weeds. |
| B) Cover crops for weed control | Clean cultivation is practiced, and therefore no cover crops are in use. | Cover crops are grown in row aisles, but stand is not thick enough for good weed control. | Cover crops grown in row aisles suppress growth of weeds and prevent weed encroachment |
| C) Cultivation | Weeds propagate readily due to insufficient or nonexistent cultivation. | Soil is moist during cultivation, causing some to propagate. Flowering types go to seed before removal. Mechanical equipment is too close to canes or roots, causing some damage. | Cultivation is practiced during dry weather as much as possible. If weeding is automated with machinery, cultivation is at least 2” away from canes and no more than 2” deep into the soil. Flowering weeds in the drive row are mown before flowers are fully open. |

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| D) Herbicides | A single herbicide program is in continuous use, resulting in new herbicide-resistant weeds. No management practices are in place to prevent surface water and groundwater contamination. | License is up to date (if applicable), label guidelines are met, and state/federal environmental laws are followed. Herbicides in use may not be selective, and weeds may develop resistance. Protective equipment is used. | Pesticide applicators license (if applicable) is up to date, label guidelines are met, and state/federal environmental laws are followed. Selective herbicides are used on targeted weeds. Proper application and use rates are in practice as well as the use of appropriate protective equipment. Herbicides with different modes of action are rotated to prevent resistant weeds. Practices to manage surface water and groundwater contamination are in place. |

| **9. DISEASE AND VIRUS MANAGEMENT** | **NEEDS IMPROVEMENT** | **SATISFACTORY** | **EXCELLENT** |
|---|---|---|---|
| A) Use of virus-free plants | Planting stock is obtained from a nursery that does not certify material to be virus-indexed. | Farmer plants only certified virus-indexed and disease-free planting stock. | Farmer plants only certified virus-indexed and disease-free planting stock; disease- resistant cultivars selected as site-appropriate. |
| B) Site testing | Site has history of soil-borne pathogens OR plant-parasitic nematodes are present. | Site has no history of soil-borne pathogens, but tests are not taken. | Soil tested for presence of plant-parasitic nematodes pre-planting; farmer ensures site does not have history of soil-borne pathogens. |
| C) Sanitation | Pruned materials are left in the field. Inconsistent sanitation of equipment. | Diseased material removed from the field. Equipment sanitized between plants when pruning out infection. | All diseased materials removed from the field and destroyed. All equipment sanitized between plants when pruning. Water sources tested for pathogens. Workers avoid tracking soil from other fields into planting on boots or equipment. |
| D) Pruning for air circulation | Plants are dense and overgrown; weeds are inconsistently managed. | Suckers and weeds are managed, but primocanes are not thinned. | Trellis system was selected for maximum air circulation, Primocanes are thinned; weeds and suckers are removed. |
| E) Irrigation minimizes wet canopy | Overhead irrigation is used; excess irrigation is common. | Care is taken to keep plants as dry as possible; soils are never saturated. | Fields are not flooded under any circumstances; plants irrigated only as needed for optimum growth. Drip irrigation used to avoid wet canopies. Soil moisture is monitored and water gauges are used. |
| F) Vector control | Scouting for insect pests occurs infrequently, predators are not used. Soil is frequently moved between fields on equipment. | Scouting for insect pests occurs, predators are used as the first management choice. | Scouting for insect pests occurs regularly, predators are released immediately when pests are observed. Care is taken to not transfer soil into field. |

| 10. FARM SAFETY | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Tools and equipment | No labels/markers exist to warn people about dangerous tools/equipment. | It is up to the tool/equipment user to report if maintenance is needed. Gloves and goggles are provided when needed. Heavy-duty machinery has caution signs. | All tools and equipment are routinely maintenanced. Safety mechanisms, if available, are checked regularly. Workers wear appropriate protective gear and attire. Signs and/or markers notify individuals of dangerous equipment. |
| B) Employee safety training | New hires begin work without safety training. | Workers are trained for safety measures, but safety protocols are rarely followed. | Workers are provided with safety training at beginning of employment, understand the hazards of the job and follow appropriate safety protocols. |
| C) Employee personal safety | Personal safety equipment is not provided for employees. | Employees have access to personal safety equipment, but do not regularly utilize it. | Employees have access to and utilize personal safety equipment and clothing (closed toe shoes, gloves, eye protection, hearing protection, sun protection, etc.). |
| D) Fertilizers | Fertilizer is stored in an open shed. It sits on the ground or on pallets near ponds, water wells or flood plains of flowing streams. | Fertilizer is stored in an unlocked building and kept out of the rain. It sits on a concrete slab but might be near ponds, water wells or flood plains of flowing streams. | Fertilizer is stored in a locked building and periodically inventoried. It sits on pallets on a concrete slab away from ponds, water wells or flood plains of flowing streams. |
| E) Pesticides and herbicides | Pesticide application license is in progress. Chemicals are stored in an open shed. They sit on the ground or on pallets near ponds, water wells or flood plains of flowing streams. | Pesticide application license is up to date. Chemicals are stored in a building and sit on a concrete slab, but might be near ponds, water wells or flood plains of flowing streams. | Pesticide application license is up to date. Chemicals are stored in a locked building and sit on pallets on a concrete slab away from ponds, water wells or flood plains of flowing streams. |

| 11. HARVEST, POST-HARVEST AND FOOD SAFETY | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Frequency and timing of harvest | Berries are harvested infrequently, during hottest part of the day, or when wet. | Berries are harvested at least twice a week, usually in the morning. | Berries are harvested every 1-3 days, in the cool of the morning, not wet from rain or dew. |
| B) Harvest containers | Berries are damaged during harvesting and handling due to stacking too deep in harvest containers. | Berries are not harvested into market containers, but are handled carefully to minimize damage when transferred into market containers. | Berries are harvested directly into market containers, not stacked more than 2-3 berries deep. |
| C) Berry quality | Berries are picked too ripe and have a short shelf life. | Some berries are picked before or after optimal stage. | Raspberries are picked before fully ripe, at pink stage. Blackberries are picked when fully ripe, at shiny black stage. |
| D) Culled berries removed | Damaged berries are left on the plant. | Most damaged berries are removed from the plant; some are left on the ground in the row aisles. | Damaged or culled berries are removed from the plant and are destroyed away from the planting. |
| E) Post-harvest handling | Berries are left in direct sunlight after harvest. | Berries are kept in the shade after harvest, but remain at ambient temperatures for more than an hour before cold storage. | Berries are not exposed to direct sunlight and are placed into cold storage with an hour of harvest. |
| F) Cold storage conditions | Cold storage is above 35°F and lacks air movement. | Cold storage is 30-35°F but lacks rapid air movement. | Cold storage is 30-35°F with 90-95% humidity and air movement to quickly remove field heat. |
| G) Food safety | Workers do not wash hands regularly before harvest and contaminated berries are picked along with clean berries. No designated “ground container” when harvesting. | | Workers wash hands before harvesting and berries with fecal contamination are avoided. Only designated “ground containers” are allowed to touch the ground when harvesting. |

| 12. BUSINESS MANAGEMENT | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Farm Business Structure | Employer has neither set economic goals nor chosen the legal business structure for the farming operation. | Employer knows economic goals but has not chosen the legal business structure. | Employer knows economic goals and has chosen the legal business structure that best enhances the farm potential for success. |
| B) Farm Business Management | Not all environmental and other government regulations are fulfilled. Production/harvest labor activities are based on observation. Workers are being supervised but not trained. Production activities and production are neither recorded nor updated. There are no financial budgets. There is limited communication with suppliers and product buyers. | Environmental and other government regulations are fulfilled. Production/harvest labor activities are based on observation. Workers are being supervised but not trained. Production activities and production are recorded but are not updated on regular basis. Financial budgets are not completed. There is communication with suppliers and product buyers. | Environmental and other government regulations are fulfilled. Production/harvest labor activities are planned and scheduled. Workers are trained as needed. Production activities and production are recorded and up to date. Financial budgets are up to date. There is good and consistent communication with potential employees, suppliers and product buyers. |
| C) Labor Issues | Employer does not provide contracts. All contract agreements are verbal. The employer is planning to display a poster that describes the rights and protections to workers to comply with the Department of Labor Migrant and Seasonal Worker Protection Act (MSPA). Employer does not provide a competitive wage. | Employer provides complete contracts to his/her employees. A poster that describes the rights and protections to workers under the Department of Labor Migrant and Seasonal Worker Protection Act (MSPA) is displayed. | Employer provides complete contracts to his/her employees. A poster that describes the rights and protections to workers is displayed. Employer provides reasonably safe tools, a safe place to work, and competent fellow employees. Employer provides a competitive wage. |
| D) Crop Insurance | Employer does not have crop policies. | Employer is working toward obtaining yield and revenue protection insurance. | Employer has crop (yield protection and revenue protection) policies. |
| E) Liability Insurance | Employer does not have any liability policy. | Employer is working toward obtaining a liability policy. | Employer has liability policies. |
| F) Participate in USDA Conservation Programs | Employer does not participate in, and is not knowledgeable of, any federal or state conservation program. | Employer is knowledgeable about state and federal conservation programs and is working toward qualifying for a program. | Employer participates in at least one federal or state conservation program. |
| G) Estate Planning | An estate plan has not yet been considered. | Employer is preparing an estate plan. | An estate plan has been written, is reviewed every three years and is stored in a secured place. |

| 13. MARKETING | NEEDS IMPROVEMENT | SATISFACTORY | EXCELLENT |
|---|---|---|---|
| A) Product | The producer does not know what the customer wants from the product. | The producer is evaluating what the customer wants from the product. | The producer knows what the customer wants from the product. |
| B) Location | The producer does not know how to access the right distribution channels. | The producer is evaluating what are the right distribution channels. | The producer knows how to access the right distribution channels. |
| C) Price | The producer has not determined the selling price. | The producer is evaluating the best alternative to determine a selling price. | The producer has determined a competitive selling price . |
| D) Promotion and advertising | The producer does not know how to promote the product. | The producer knows “where” and “when” but does not know “how” to get marketing messages to the target market. | The producer knows “where,” “when” and “how” to get marketing messages to the target market. |
| E) Marketing Options | The producer does not know his/her marketing options. | The producer knows his/her marketing options but does not have agreements to sell the product. | The producer has agreements to sell in the fresh market and/or in the processed market. |

# Notes

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