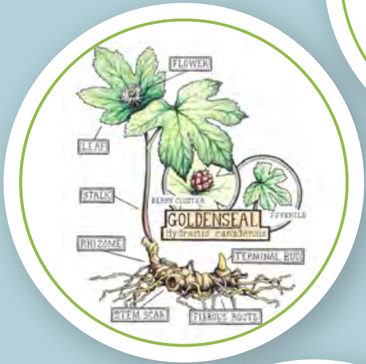
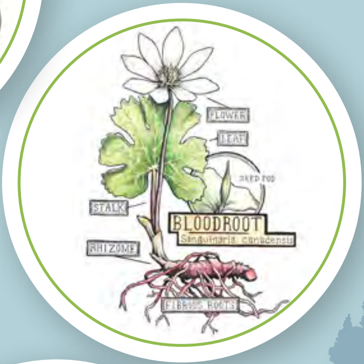
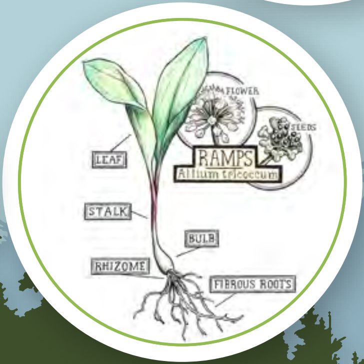
The Forest Farmers Handbook







A Beginners Guide to Growing and Marketing At-Risk Forest Herbs

By Rural Action and United Plant Savers

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Preface

This booklet represents the culmination of nearly two years of research about forest farming cultivation and management practices, medicinal plant conservation, and sustainable market development. The initial motivation for this publication emerged from the intersection of new challenges and opportunities facing the herbal products industry. We are currently witnessing the growth in interest and the use of herbal products as a means to maintaining health and wellness. However, as herbalism regains its place in the "mainstream" of modern society, it is eliciting a unique set of problems and concerns. Where once herbal enterprises were few and far between, we now find a highly competitive marketplace, which places increased demand on wild plant resources. Furthermore, countries with an uninterrupted tradition of herbalism are experiencing shortages of botanical raw materials and increasingly look to the North American continent as a supplier of medicinal plant products.

Private management of woodland resources in the Appalachian region is at a critical transition as the next generation takes on the important role as landowners. Forest farming for medicinal plants presents a conservation opportunity, which is to provide landowners the tools to consider the herbaceous diversity of woodlands in their management decisions. Forest Farming of native medicinal plants seeks to address a conservation concern for medicinal plants, while providing an innovative approach to long-term biodiversity enhancement. The Forest-Grown Verification Program (FGV), discussed in further detail throughout this booklet, seeks to not only provide value-added return for the forest farmer, but it seeks to create incentives for forest conservation. The FGV program ties together the health of the ecosystem and the demand for medicinal plants—therefore, as the herbal products industry grows, we are helping to conserve biodiversity rather than depleting forest resources. This is at the heart of the concept of conservation as form of innovation. Forest farming is an innovation that serves a conservation priority to mitigate the depletion of native medicinal plants. To achieve this mission of plant conservation we need forest farmers, as well as companies and consumers to support the FGV concept and foster a stronger conservation ethic.

Chapter 1

Forest Farming Production Methods & Site Selection

What is forest farming?

If you're reading this, you're probably interested in forest farming. And if not, perhaps you should be—forest farming can provide economic opportunities to the forest landowner or land steward while also providing significant environmental benefits, such as preserving forest cover and enhancing biodiversity through the reintroduction and establishment of new populations of at-risk forest herbs. So, whether you're interested in earning a supplemental income from your woods or contributing to the conservation of native species, forest farming has something for you.

Let's start with a definition: forest farming is an agroforestry practice which cultivates medicinal, edible, decorative, and handicraft crops under a forest canopy that is modified or maintained to provide shade levels and habitat, which favor growth and enhance production of a desired species or mixture of species (Chamberlain et al. 2009). In other words, it is the practice of using the forest understory to produce commercially valuable agricultural products other than timber.

While forest farming can take many forms, this book will focus on the intentional cultivation of understory herbs, with a special focus on five species—ginseng, goldenseal, ramps, bloodroot, and black cohosh. These five species are of particular interest because they are predominately sourced through wild-harvested supply chains and are of high conservation concern due to overharvesting and habitat loss. The market value for plant products currently exceeds $8 billion dollars annually in the United States (Smith et al. 2018), representing a potential economic opportunity for forest landowners and aspiring forest farmers. As the herbal products industry continues to grow, so does the need and demand for raw materials that are intentionally, sustainably, and verifiably produced. The goal of this publication is to provide forest farmers with the best available information and tools needed to achieve these benchmarks and successfully enter the market.

Forest Farming Production Methods

For the forest farmer, determining which production method or combination of methods to use will depend on your goals, the attributes of your forest, and the amount of time and money you want to invest in your forest farming operation. Three forest farming methods are typically used to produce medicinal forest plants for market: 1) wild-simulated production, 2) woods-cultivated production, and 3) wild-stewarded/stewardship harvesting. Each method has its own unique attributes, which are described below in further detail.

Wild-simulated production

As the name implies, the goal of wild-simulated production is to encourage the development of low to medium-density plantings that are virtually indistinguishable from truly wild populations, relying on the natural conditions of the forest to provide the habitats necessary to sustain the growth of one or more species. Wild-simulated plantings are typically started from seeds that are purchased from a commercial supplier or collected on-site from an existing population, but can also be started from rootlets. Planting seeds using the wild-simulated method, which simply involves raking back the leaf litter and broadcasting seeds at a specific density, enables more natural population dynamics to develop and can help facilitate the growth of mixed-species polycultures.

Wild-simulated production is a good choice for small to medium-scale producers because it typically requires fewer investments in time, labor, and inputs than more intensive forms of production (*e.g.* woods-cultivated) and can produce the highest-value products when wild-type characteristics are desired (*e.g.* American ginseng). Additionally, low density wild-simulated plantings are less susceptible to the spread of fungal diseases and pathogens, helping the grower avoid the need for costly chemical interventions.

Woods-cultivated production

The woods-cultivated method is a more intensive form of production where habitat conditions are typically altered to support the growth of large high-density plantings. Alterations can include removing understory and mid-level vegetation to reduce competition and optimize light conditions, and shallowly tilling the soil to accelerate growth and increase yields. It is worth noting that yield differences between wild-simulated and woods-cultivated production methods can be significant. For example, production budgets indicate that yield estimates for ½ acre of woods-cultivated ginseng would net approximately 300 lbs. of dried root, whereas the estimated yield for the same acreage using wild-simulated methods would only net 80 lbs. of dried root (Davis and Persons, 2014).

While this approach has several benefits—most notably higher root yields and seed production—it can also introduce new challenges. The amount of labor required for site preparation, crop maintenance, and harvesting are higher, and may require investments in costly equipment, such as a tractor, heavy-duty tiller, and/or mechanical sprayers. Depending on the species being cultivated, high-density plantings of a single species may also increase the potential for disease outbreaks and the need for chemical controls (*e.g*. fungicides).

Regardless, an effective disease management protocol, whether needed or not, should be part of any woods-cultivated operation in case an incident occurs.

Additionally, forest farmers should consider how woods-cultivated practices may affect the value of their product. In some cases, specifically with American ginseng, plants produced in tilled beds may appear to have more cultivated characteristics than wild-simulated roots and can result in a lower market value when wild characteristics are desired (*e.g.* wild/Asian market) (Beyfuss, 2002). Species like goldenseal, black cohosh, and bloodroot are not typically valued based on the physical appearance of the root and may make better candidates for woods-cultivated production. Overall, the woods-cultivated method is best suited for medium to large-scale forest farming operations with adequate time and resources to invest but can also be utilized in small-scale forest farming applications if desired.

Wild-stewarding/Stewardship Harvesting

It is not uncommon for landowners to encounter wild populations of herbs on their land that they are also interested in bringing to market. Stands of wild ginseng, goldenseal, ramps and other species can be managed or stewarded in a way that provides marketable products while also helping to ensure the long-term survival and sustainability of the population. By collecting and planting seeds from mature plants and utilizing the principles of forest farming, a wild population can quickly evolve into a self-sustaining wild-simulated population. The takeaway is that wild-stewarding can be a promising way for forest farmers to hit the ground running and enter the market early, as long as population management is done in a sustainable way. The guiding principles of wild-stewardship require that management activities be done in a sustainable manner, such as:

- Only harvesting mature plants bearing ripe seeds
- Planting all ripe seeds at the time of harvest or subdividing and replanting a section of rhizome for species that can be propagated by root cuttings
- Leaving an adequate number of mature reproductive plants to ensure future reproduction

Establishing appropriate harvest levels for wild-stewarded populations is an essential component of sustainable management. Species life cycle traits, reproductive capacity, and the size of the population being managed will all influence how much material can be harvested without causing adverse impacts to the population. For example, research on the harvest of wild ramps suggests that a sustainable harvest level would be no more than 10%-15% of a population in a single year (Greenfield and Davis, 2001). For species with lower rates of reproduction and higher mortality, such as American ginseng, a sustainable rate of harvest may be no more than 10% of a single population over a 5 to 10-year period. It is important to note that growth rates, reproductive capacity, and response to harvest can vary significantly between populations, growing sites, and between species. It is essential for the wild-steward to observe these processes over several consecutive years and to adjust management accordingly to ensure the long-term viability and productivity of the population.

Site Selection

Unlike most traditional agricultural crops, forest herbs require specific and unique environmental conditions to thrive. While each species of herb has slight variations in the habitat conditions they prefer, there is significant overlap between the five species featured in this publication. In this section we will focus on the general site selection guidelines that are common to all five species. More detailed descriptions specific to each species are included in the cultivation guides located in section 3.

For the beginning forest farmer, selecting good planting sites is a critical, and often challenging first step. Growing sites can be identified and evaluated at any time of the year, but it is important to keep in mind that sites can change significantly with the seasons and should be examined several times to see how conditions might change over the course of a year (Dorner, 2002). Key elements to examine and consider include:

- Topography (*e.g.* slope and aspect)
- Vegetative composition (*e.g.* indicator species)

- Hydrology
- Soil quality and characteristics
- Site security and accessibility
- Current or historic sources of potential contamination
- Altitude/USDA Plant Hardiness Zone Maps

The good news is that there are many tools available to assist with identifying good planting sites, including:

- Current and historic aerial photos
- Digital satellite imaging, such as Google Earth, or County Auditors' websites
- Topographic maps
- Soil Surveys
- Vegetation surveys
- Local Forestry and Agricultural Extension agencies

Topography and Land Use History

A good place to start when trying to locate potential planting sites is to examine the topographical features of your property. Topography simply refers to the natural and artificial features of the landscape. Key features relevant to the forest farmer include things like the forest canopy cover, the species of trees and herbs present, slope, drainage, aspect (directional orientation), and soil quality. While all of the elements are important in their own right, two topographical features are particularly useful in the site selection process: slope and aspect.

Slope is simply a measurement or estimation of how steep the terrain is on a given site and is typically expressed as a percentage (*e.g.* 10% slope). Planting sites with gentle to moderate slopes (*e.g.* 5%-15%) are considered ideal for forest farming. Gentle and moderately sloped sites help facilitate drainage and prevent water from accumulating in the growing site, retain more leaf litter on the forest floor, and make it easier to plant seeds and harvest roots. Flat sites (*e.g.* < 5% slope) can still be great for forest farming applications, as long as the site is well drained and does not remain saturated for extended periods of time. Steeply sloping terrain (e.g. >15% slope) can create additional challenges for the grower but should not be overlooked as potentially viable production sites.

Aspect is the cardinal direction (*e.g*. North, South, East, and West) that a slope or other landscape feature faces. Directional orientation can significantly influence the conditions of a given site, such as moisture availability, vegetative composition, soil composition, and temperature. In the Northern Hemisphere, North and East facing aspects tend to have the right set of conditions to naturally sustain diverse forest herb communities, and thus tend to be well suited for forest farming production. Due to their orientation, North and East facing aspects avoid prolonged exposure to the high intensity mid-day sun, which helps create the cool and moist conditions that forest herbs require.

South and West facing aspects, which receive direct exposure to mid-day and afternoon sun, are typically too hot and dry to support forest herb cultivation. But keep in mind that landscapes are highly variable and that small areas with suitable habitat conditions may still be present on these aspects. It is not uncommon to find indicator trees and herbs on the lower portion of a south or west facing slope where the amount of shade, soil moisture, and temperatures may differ from the predominant conditions found in the surrounding area, creating what is often referred to as a "*micro-site*" (Sanders and McGraw 2005). Micro-sites are considered "secondary" planting sites, but they may still represent good planting opportunities, especially for those with small forest holdings, those who have fully planted their primary sites.

Site Assessment Tools

Digital satellite images are a useful way for assess the topographical conditions of your property and to get a general sense of where your potential planting sites are located. Free tools, like Google Earth and similar programs, provide 3-D satellite images with topographic map features that can be used to quickly identify the forested North and East facing portions of your property that should be investigated for additional positive indicators.

Historic aerial photos can help identify the portions of your property that have experienced the least land-use change and, more specifically, areas that have been forested the longest. Historic photo sets, which typically span from the early 1950s to the present day, can enable you to identify areas that may have been previously harvested for timber, cleared for agriculture, or potentially used for other industrial purposes. Previously logged and/or farmed sites can still be highly suitable for forest farming, but site quality will ultimately depend on the type, intensity, and duration of past land use as well as how long the land has had to recover since the last disturbance. Disturbed sites may suffer from degraded, compacted, or eroded soils, and should be closely evaluated. Overall, the portions of your property that have been forested the longest will be the most likely locations to find suitable planting sites. Copies of the historic aerial photo sets for your property can usually be obtained from your State Division of Forestry.

Historic and current sources of potential contamination should always be considered when evaluating potential planting sites. How close is the site to existing contamination threats? Was the site formerly used for housing, commercial, or industrial uses? Is the site an old orchard or other former agricultural site that may contain pesticide or chemical residues? If the area is near a creek or stream, where does the water that flows through the site come from? Unfortunately, the answers to these types of questions are not always easy to find, especially in regard to historic activities that may have occurred before you acquired the property, or before you were even born! This is another way that historic aerial photos can be of use. The photos can't tell you whether or not a previous owner used DDT, sprayed herbicides, or had a burn pile, but by knowing where general types of land use activities occurred, you will have a better estimate of the risk for potential contamination and where professional testing may be needed.

Vegetative Composition and Indicator Species

After you have assessed the topographic conditions of your property, and have identified your potential planting sites, the next step will be to examine the conditions on the ground to look for other positive indicators. One of the best ways to visually assess the site is to examine the types and species of vegetation already present. What species of trees are growing on the site? How old are they? Are there well-developed herb and wildflower communities already present? By learning to identify the trees, shrubs, and herbs that are commonly found in good forest farming habitats you will be able to quickly obtain valuable information about the suitability of potential planting sites.

Below is a list of trees and shrubs that are commonly found growing in association with American ginseng, goldenseal, black cohosh, bloodroot, and ramps. Keep in mind that this is not an exhaustive list and that species composition will vary based on your geographic location, and past land use history. Learning to identify as many of these species as possible will be a valuable tool as you pursue your forest farming goals.

Trees and Shrubs

- Sugar maple (*Acer saccharum*)
- Tulip poplar (*Liriodendron tulipifera*)
- American basswood *(Tilia americana)*
- White ash (*Fraxinus americana*)
- Northern red oak *(Quercus rubra)*
- Yellow buckeye *(Aesculus flava)*
- Cucumber Magnolia *(Magnolia acuminata)*
- Birch spp. *(Betula* spp*.)*
- American beech (*Fagus grandifolia*)
- Black walnut *(Juglans nigra)*
- Slippery elm *(Ulmus rubra)*
- Pawpaw (*Assimina triloba*)
- Black Haw (*Viburnum prunifolium*)
- Spicebush (*Lindera benzoin*)
- Shagbark hickory *(Carya ovata)*

Source: (Apsley and Carroll, 2013; Burkhart, E.P., 2013; Cornell Agroforestry Working Group, 2002).

Many of the tree species listed above produce leaves that are thin and decompose rapidly, contributing fresh organic matter to the soil, and helping to improve soil quality over time. Several species, most notably sugar maple, tulip poplar, basswood, and black walnut, have relatively high concentrations of calcium and other essential micro-nutrients in their leaves, which have been found to be important for the growth and development of many forest herbs. Studies examining growing site suitability suggest that calcium is often a limiting micro-nutrient for ginseng and other forest herbs (Beyfuss 2000; Persons and Davis 2005), underscoring an important ecological relationship between forest composition and growing site suitability.

While the composition of trees and shrubs can provide valuable information about a site, the best visual indicator is the presence of wild herb populations in the area you are interested in cultivating. The species covered in this booklet—ginseng, goldenseal, ramps, bloodroot, and black cohosh—overlap in much of their preferred habitat; thus, finding wild populations of bloodroot or black cohosh may indicate that the site will also support ginseng and goldenseal, or vice versa. Keep in mind that these species are slow to reproduce, and many wild populations have been adversely impacted by a long history of over-harvesting, deforestation, and land use change, so the absence of large populations in a potential planting site does not necessarily mean that it is a bad location. Below is a list of common herbs and wildflowers that are commonly found in suitable forest habitats.

Herbs and Wildflowers

- American ginseng (*Panax quinquefolius*)
- Spring Beauty (*Claytonia virginica*)
- Virginia Bluebells *(Mertensia virginica)*
- Hepatica (*Hepatica nobilis*)
- Cut-leaf Toothwort (*Cardamine concatenata*)
- Dutchman's Breeches *(Dicentra cucullaria)*
- Squirrel Corn (*Dicentra canadensis*)
- Showy Orchid (*Galearis spectabilis*)
- Goldenseal (*Hydrastis canadensis*)
- Ramp (*Allium tricoccum*)
- Baneberry spp. *(Actaea* spp.*)*
- Bloodroot (*Sanguinaria canadensis*)
- Black cohosh (*Actaea racemosa*)
- Maidenhair fern *(Adiantum pedatum)*
- Rattlesnake fern (*Botrychium virginianum*)

- Jack-in-the-pulpit *(Arisaema triphyllum)*
- Wild ginger (*Asarum canadense*)
- Blue cohosh (*Caulophyllum thalictroides*)
- Solomon's seal (*Polygonatum biflorum*)
- False Solomon's seal, aka Solomon's plume *(Maianthemum racemosum)*
- Trillium spp. *(Trillium* spp.*)*
- Enchanters Nightshade *(Circaea lutetiana)*
- Mayapple (*Podophyllum peltatum*)
- American elderberry (*Sambucus canadensis*)
- Virginia creeper (*Parthenocissus quinquefolia*)
- False Unicorn (*Chamaelirium luteum*)

Sources: (Apsley and Carroll, 2013; Burkhart, E. P., 2013; Cornell Agroforestry Working Group, 2002).

Determining Percent Shade

Being able to determine how much shade is provided by the forest canopy will not only help you to identify good forest farming sites, but will also help identify where light conditions can be managed and optimized to enhance plant growth and development. For example, ginseng tends to grow best under approximately 75% shade, while species like black cohosh tend to grow more vigorously when greater quantities of sunlight are available (*e.g*. 60% - 65% shade). It is not uncommon to find sites that are too densely shaded for optimal growth (*e.g.* 90% shade) and can be optimized by thinning and removing small amounts of vegetation to increase light availability.

A quick method for approximating percent shade is described below:

"Place 10 or more white paper plates at even distances on the ground at approximately noon on a sunny summer day. Count the number of plates that are at least half shaded. Next, divide the number of shaded plates by the total number of plates placed on the ground. Multiply this number by 100. If this number is 70 or greater the site is probably shady enough to grow ginseng" (Apsley and Carroll, 2013).

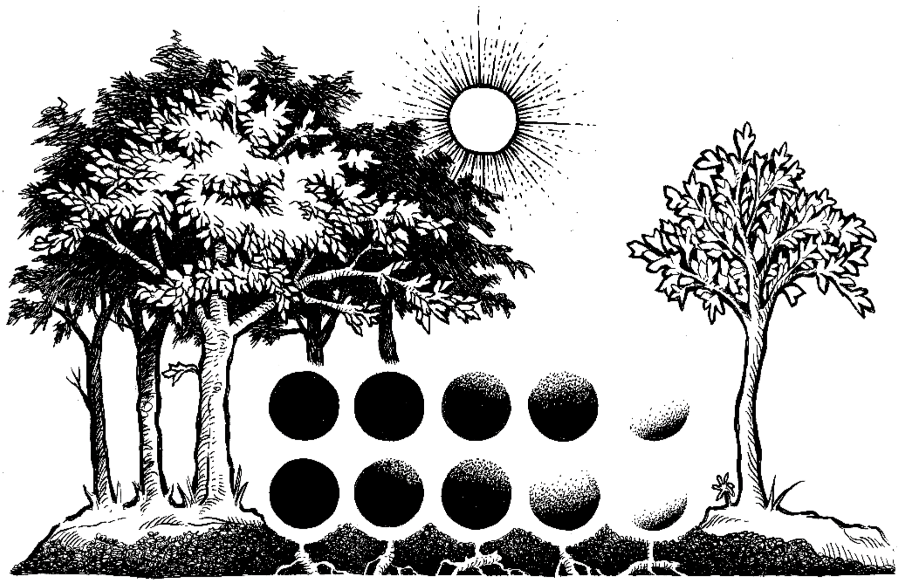


Figure 1. Ten plates total, eight of the plates are at least 50% shaded. 8/10 x (100) = 80% shade

Assessing Soil Characteristics and Quality

Soil Surveys and Soil Maps

Soil quality is one of the most important factors that can influence the overall success of a forest farming site. Soil characteristics, such as pH, texture, organic matter, and density, will all influence plant health and survival (Dorner, 2002). A site that has established communities of the trees and herbs previously discussed will most likely have soil conditions that are suitable for forest farming. But it is important to note that soil conditions can vary significantly within a small area, and the vegetative communities present may have been influenced by past land use as much, or more than the prevailing soil conditions. For these reasons, it is useful to obtain a copy of the soil survey for your property to help you make better informed management decisions. Soil maps and formation descriptions are available online and can be accessed through the *Natural Resource Conservation Service's Web Soil Survey* (https://websoilsurvey.sc.egov.usda.gov). If accessing these resources over the internet is not an option, printed copies of county-level soil surveys may also be available at your local library, or through your local Soil and Water Conservation District office.

In addition to soil maps, a soil nutrient analysis can be conducted to further assess soil quality. If a soil test is necessary or desired, contact your local agricultural extension agent or soil and water conservation office to find a testing service in your area. It is important to follow the testing services soil collection guidelines to ensure accurate results. Soil samples are typically collected with a soil probe or other cylindrical core at a depth of 20 cm. Collect samples from several locations within the site to account for natural variability (Dorner, 2002).

What you're looking for in your soil analysis:

- At least 10% organic matter
- At least 95 lbs./acre available phosphorus
- At least 2,500 lbs./acre available calcium but optimally above 3,000 lbs./acre
- pH of 5.0 – 7.0 (±0.5)

Source: (Beyfuss, 2000; Hankins, 2000; Burkhart, 2013; Naud et al., 2010).

Soil pH:

Soil pH is a measurement of soil acidity or alkalinity and has a direct influence on the ability of plants to uptake nutrients from the soil (Dorner, 2002). The pH scale ranges from 0 to 14, with values from 0 to 7 being acidic, and values from 7 to 14 being alkaline. Most forest herbs prefer soils that are slightly acidic, with pH values ranging from 5.0-7.0 (Burkhart, 2013; Naud et al., 2010). Soil pH can be measured on-site using a battery-operated wet bulb pH meter or paper pH testing strips by following the steps below:

1. Mix ¼ cup soil with ¼ - ½ cup water, using just enough water to mix soil into a paste
2. Let the mixture sit for 30 minutes
3. Stir again
4. Submerge pH meter or test strip in mixture, and evaluate using the classifications below, or provided with the testing device

pH	Classification
<5	Strongly acid soils
5 - 6.5	Moderately acid soils
7	Neutral Soils
7 - 8.5	Alkaline soil
8.5 or higher	Strongly alkaline soils

Soil Texture:

Soil texture refers to the percentages of sand, silt, and clay present in a soil sample. Soil texture is important because it can significantly influence the water holding capacity and nutrient availability of a potential planting site (Dorner, 2002). For example, too much sand, and the soil may be too dry; too much clay, and the soil may not drain well enough, leaving your plantings more susceptible to disease. The goal is to locate sites with soils that have a balance of these textural characteristics. Silt-loam soils, those that have balanced proportions of sand, silt, and clay, are both moist and well drained and typically have relatively high levels of organic matter. The silt-loam formations on your property can be easily located using your county-level soil survey and soil map as previously described.

Fertilizers and Soil Amendments

Unlike many traditional crops, forest herbs are more sensitive to added fertilizers and soil amendments, and in some cases these inputs can have a negative effect on growth or alter the physical appearance of the roots. For example, forest-grown ginseng roots will grow rapidly in response to additions of nitrogen or phosphorus rich fertilizers, but faster growth may result in a root that is closer in appearance to field-cultivated ginseng, ultimately decreasing the potential value of the final product. If fertilization is needed, it is recommended to use natural and mineral-based amendments that breakdown slowly and release nutrients over time, such as composted leaf litter, pelletized gypsum, or rock phosphate. A slow release of nutrients over time, rather than a quick dose of synthetic fertilizer that is immediately available to the plant, will help reduce or eliminate the risk of altering the plants' physical characteristics, while simultaneously enhancing growth and improving soil structure and quality over the long term.

As previously mentioned, calcium is often a limiting factor in many growing sites and is essential for plant growth and development (Apsley and Carroll, 2013; Beyfuss, 2000; Persons and Davis, 2005). If soil calcium concentrations are low, pelletized gypsum (*Calcium sulfate*) can be used to increase calcium content without significantly altering soil pH.

Planting Site Preparation

Depending on your goals and the production method being used, planting site preparations can range from minimal to intensive. Below is a brief overview of common site preparation activities for both wild-simulated and woods-cultivated production methods.

Wild-Simulated Preparations

The goal of wild-simulated production is to mimic wild conditions as closely as possible. This does not necessarily mean taking a hands-off approach and often involves making some minor alterations to the site in order to optimize growing conditions. Common wild-simulated site preparation activities include:

- Pruning or mechanically removing small trees and shrubs to improve airflow and optimize light conditions
- Manual removal of invasive or highly competitive plant species
- Applications of composted leaf litter or other natural/mineral-based soil amendments (*e.g.* pelletized gypsum, composted leaf litter, etc.)

Woods-Cultivated Preparations

Being a more intensive method of production, site preparations for woods-cultivated production are often more extensive. The extent of modification will depend on the intensity and scale of production being pursued. Woods-cultivated alterations could include any of the activities previously listed for wild-simulated preparation but may also include:

- Mechanical or chemical removal of understory vegetation and mid-story trees
- Tilling the soil and forming raised beds (approx. 2”- 6”)

Site Security and Accessibility

Site security should be a primary consideration for anyone who is considering starting a forest farming business. Forest farming requires a significant investment of time, labor, and resources, and the theft of your crop—often referred to as poaching—can be devastating. Unfortunately, due to the long history of wild-harvesting associated with the species featured in this publication, crop theft is all too common, especially for higher-value species like ginseng, goldenseal, and ramps. While there is no clear solution for solving the problem of crop theft, measures can be taken to bolster site security and deter would-be poachers. Things to consider when evaluating site security include the proximity to roads or other points of access, the distance from adjacent property boundaries, and how easily the site can be monitored.

Some of the security measures listed below may seem to contradict one another, but that is because what works best for one landowner may not be the best approach for another. Ultimately, you should experiment with different strategies and figure out which approaches work best for you. Several measures that may help to improve site security include:

- *Choose planting sites close to your residence.* By far the best security measure is to select planting sites that are close to your home. This provides you the opportunity to check on your crops regularly and to intervene early in the event of any theft.

- *Plant smaller plots over a large area.* By spreading your plantings out across your property, you can minimize the impact of any single theft event.
- *Cut back or harvest leaves after seeds have matured.* Some herbs, like American ginseng, are easier to spot when the ripe red berries are in full display as the leaves begin to turn bright-yellow in the fall. By harvesting the ripe berries (mid-August through mid-September) and cutting back the yellowing leaves, the threat of theft can be greatly reduced. By this point in the season, the plant has already produced next year's bud, and cutting back the leaves should not adversely affect the plant's health.
- *Keep your forest farm a secret.* As a way to minimize the chances of a would-be poacher learning the whereabouts of their growing site, some forest farmers choose to only tell their closest family and friends that they are growing profitable herbs in their forest.
- *Don't keep your forest farm a secret.* Other landowners choose to let their neighbors and local natural resource professionals (*e.g.* wildlife officers, service foresters, extension agents) know what they are doing and enlist their help in keeping an eye out for would-be poachers.
- *Post signs and mark boundaries.* In the event of a theft, having all of your property boundaries clearly marked, as well as having private property and no trespassing clearly posted, will show that you have done your due diligence and can help prove that a trespassing or theft offense has occurred.
- *Cameras, dogs, fences, etc.* Depending on your situation, additional security tactics can include having dogs roam the property freely, posting real or fake cameras in conspicuous or not so conspicuous locations in your woods, fencing off portions of your property, or installing digital tripwires and alarms near your plantings or property access points.

Source: Apsley and Carroll, 2013.

Obtaining Plant Stock

Genetic and Geographic Considerations:

In recent years the forest farming community has become increasingly interested in, and aware of, the genetic and geographic origin of commercially produced planting stock (*e.g.* seeds and rootlets). Of particular interest to growers are how genetic attributes and geographic adaptations contribute to a plant's overall chances for survival and long-term success in a forest farming production system. For example, how does a seed obtained from 3-year old field-cultivated ginseng plant from Wisconsin perform compared to a seed collected from a 25-year old wild plant from West Virginia? Which seed has the best chance of surviving 10-15 years before it can be harvested and sold? Which seedling will be more drought-tolerant or disease resistant? Unfortunately, these, and many other questions, are relatively new among the forest farming community and have not been fully researched to date.

As a general rule, growers should try and source plant material from their local area or region whenever possible. Locally and/or regionally-sourced planting stock will be representative of a specific "ecotype" that is more likely to be adapted to the climatic conditions of your area and will exhibit similar germination and flowering times, disease resistance traits, and/or other characteristics that may be of interest to growers (Dorner, 2002). Another advantage of sourcing locally is that it may give you the opportunity to visit the farm where the material was produced and see how the material was grown and handled prior to purchasing.

Evaluating Plant Material:

Finding a source of quality planting stock is an essential step towards developing a successful forest farming business. The roots and seeds that you plant today will not only become your final marketable products but will also be a source of future planting stock. To help ensure the best results, all plant material (*e.g.* roots and seeds) should be evaluated prior to purchasing and/or planting (Dorner, 2002). Since there are no industry standards governing the production of forest botanical nursery stock to help ensure uniformity among species and products, growers must familiarize themselves with the characteristics of the species they are purchasing, as well as the signs and symptoms that may indicate potential problems. Some important things to look for when evaluating plant material include:

- Visibly healthy rhizomes with vigorous fibrous roots
- Signs of mold, insects, or disease
- Visible signs of injury from a digging tool, etc.
- Broken or damaged terminal buds
- Presence of roots/seeds from other species
- Healthy and fully developed seed embryos (*e.g.* not discolored or dried out and filling the entire seed hull)

Source: (Dorner, 2002).

Keep in mind that some of the negative characteristics listed above are not always detrimental to the survival of the plant, and some incidences are to be expected when dealing with large quantities of material. But if the majority of the material examined has been negatively affected, then it may be best to find an alternative source (Dorner, 2002).

Chapter 2

Botanical Markets and Forest Grown Verification

Markets for Herbal Products

International Markets:

Forest herbs have been commercially harvested from the forests of eastern North America and sold into international markets for over three centuries. In fact, 2017 marked the 300th anniversary of the first export of American ginseng from North America to China, initiating a market that would help to fuel the early American economy along with commodities like furs and sassafras root bark (Fontenoy, 1997). The Asian market continues to drive the high price of American ginseng, which is often a centerpiece of forest farming operations in the eastern United States (Workman et al. 2003). Other forest herbs, such as goldenseal and black cohosh, are still exported in significant quantities, but the demand for these products overseas has not resulted in significant domestic price increases.

Selling herbs into the export market is a complex process and will typically require some extra work on behalf of the grower, such as connecting with an exporter or overseas buyer, obtaining export permits and/or meeting export specifications, negotiating a price, and meeting buyer specifications for drying, packaging, and storage. Keep in mind that the amount of time invested will vary depending on the quantities being shipped, your position within the supply chain, and level of access to overseas markets. Without having well-established overseas market connections, growers will likely be several steps removed from the export process and will rely on wholesale aggregators to purchase and export the products they produce. While some growers may want to invest the extra time and effort required to export directly, others may choose to focus on the production side of the business, recognizing that each person and/or step in the supply-chain has a function and purpose, and adds value to the overall process. For example, ginseng export markets are highly coveted and often tightly controlled by established dealers, making it difficult for growers to access them directly. Ginseng roots destined for overseas markets are typically resold through a series of buyers and aggregators, ultimately ending with an exporter who has the proper permits to legally export the material. So, after the initial point of sale, the grower remains several steps removed from the process. Keep in mind that without having direct access to overseas markets, this scenario will hold true for growers of any species, and it may be more advantageous to work on developing domestic market opportunities that are less reliant on outside market forces and capitalize on direct to manufacturer and consumer sales.

Domestic Markets:

Domestic herb markets can take many forms: a local apothecary making and selling herbal medicine, an herb shop in a large city serving an international demographic, a high-end restaurant looking for native edibles such as ramps, a nursery or landscape company that utilizes native medicinal species, or a well-established herbal products manufacturer. Historically the options for making these types of domestic sales have been limited and under-developed when compared to traditional wholesale and export markets but have become more accessible in recent years. Since each link in the supply chain earns a commission on sales, selling directly to manufacturers, retailers, and consumers can ultimately help increase a grower's profit potential (Davis and Persons, 2014), especially early on when wholesale quantities may be lacking (Carpenter and Carpenter, 2015).

Domestic buyers may be willing to offer premium prices for high-quality, small-batch herbs, but increased profitability does not come without extra effort, such as conducting market research, building relationships with multiple buyers, and maintaining necessary records and/or certifications to satisfy buyer specifications. Whether selling to a large manufacturer or small apothecary, growers should be prepared to demonstrate their ability to successfully "do business" before approaching a prospective buyer, such as being able to discuss growing, harvesting, and processing procedures for all crops; having protocols and procedures in place to ensure proper product identity and traceability (Carpenter and Carpenter, 2015); or being able to discuss industry trends and market dynamics (Davis and Persons, 2014). Specific things growers will want to determine or have in place before contacting a potential buyer include:

- The amount of product available and the desired selling price
- Organic certification, or other certification/verification certificates if requested
- A tracking and inventorying system for all products, including harvest dates, plant parts harvested, harvest locations, and specific lot numbers
- Botanical identification sheets or certificates of analysis if applicable
- Voucher specimens or batch samples for microbial testing and analysis
- When contacting a specific company, request a harvest specifications sheet so you are clear about what the company wants

Source: (Carpenter and Carpenter, 2015).

Forest Grown Verification, Sustainability, and Brand Development

As the market for medicinal plant products has continued to grow, so has consumer awareness about the conservation issues associated with the harvest of at-risk forest herbs from the wild. Growing conservation awareness has helped build momentum around sustainable branding and market development initiatives aimed at promoting the intentional and profitable cultivation of forest herbs. Transitioning from wild-collected to forest-cultivated supply chains is challenging, even for the few priority species featured in this manual. Current market prices for most forest herbs are based on the economics of wild-harvested materials, which do not always reflect the additional costs incurred by forest farmers when trying to bring a crop to maturity. In many cases, these prices are below the cost of production for forest farmed alternatives, placing growers at a competitive disadvantage or making cultivation financially unfeasible altogether (Burkhart and Jacobson, 2009).

In order to raise market prices to levels that support forest farming businesses, industry supported certification and labeling programs that distinguish forest farmed products in the marketplace, and incentivize forest-based production through premium pricing, will likely be needed to help facilitate this transition (Burkhart and Jacobson, 2009). Currently, the Forest Grown Verification (FGV) program administered by United Plant Savers (UpS) is the only third-party verification system established to authenticate and verify the origin of forest farmed herbs and other non-timber forest products (NTFP's) in the eastern United States. The FGV program standards are the result of extensive discussions between forest farming stakeholders—growers, buyers, academics, and Technical Service Providers (TSPs)—and the desire to create a system that is applicable to a wide variety of forest farming practitioners. The FGV system has multiple goals, including:

- Generate premium prices for growers of FGV products
- Promote a "Conservation Through Cultivation" approach to at-risk species conservation and help transition the forest-based herbal products sector away from wild-harvested plant material
- Help distinguish Forest Farmed products in the marketplace by increasing consumer awareness and strengthening domestic market opportunities
- Establish clear guidelines for sustainable plant cultivation, harvest, and management
- Create direct pathways between growers and buyers to reduce supply chain "middlemen" and increase grower profitability
- Support traceability and compliance in the forest-based herbal products supply chain through record keeping and third-party auditing

A critical step towards accomplishing these goals will be to educate buyers and consumers about the benefits of purchasing forest farmed and/or products bearing the FGV label. Educational efforts should draw attention to key buyer and consumer level benefits, including:

- Assurances regarding product identity
- Confidence in product source and origin
- Documentation of production and post-harvest handling procedures
- Knowledge that purchases are helping support small farms, forest farmers, and medicinal plant conservation

Without distinguishing how forest farmed and/or FGV products differ from their traditional counterparts, it will be difficult to expand direct market opportunities and increase profitability for producers (Burkhart and Jacobson, 2009). One of the overarching goals of this publication is to provide forest farmers with the tools, information, and resources needed to start, manage, and maintain a successful forest farming operation and prepare to take advantage of emerging market initiatives, including FGV, direct-to-market, and value-added opportunities.

The FGV Process

Similar to organic certification, growers who are interested in obtaining an FGV designation are required to submit an application and Forest Grown System Plan (FGSP) that documents the cultivation practices used in the production process, the source and quantity of planting stock materials, and planting maps and population size estimates, as well as any natural or chemical inputs applied to the crop. The application process is followed by an on-site inspection to ensure that your operation meets all FGV standards and requirements. This typically includes an inspection of all harvest and production areas and/or processing facilities for handlers of FGV materials to ensure that what is observed on-the-ground matches the information provided in the FGSP. After the inspection, if all criteria are met, a Certificate of Verification is issued and the process is complete. In order to help maintain the integrity of the program, inspections are re-occurring and are currently required once every three years or during any year of harvest.

As with most third-party auditing systems, there are costs and fees associated with participation. On average, the application, inspection, and re-inspection processes cost about $300 and will cover up to three years of enrollment in the program, or until your first harvest and re-inspection, whichever comes first. For more information about the FGV program contact United Plant Savers directly.

Sustainability in Forest Farming

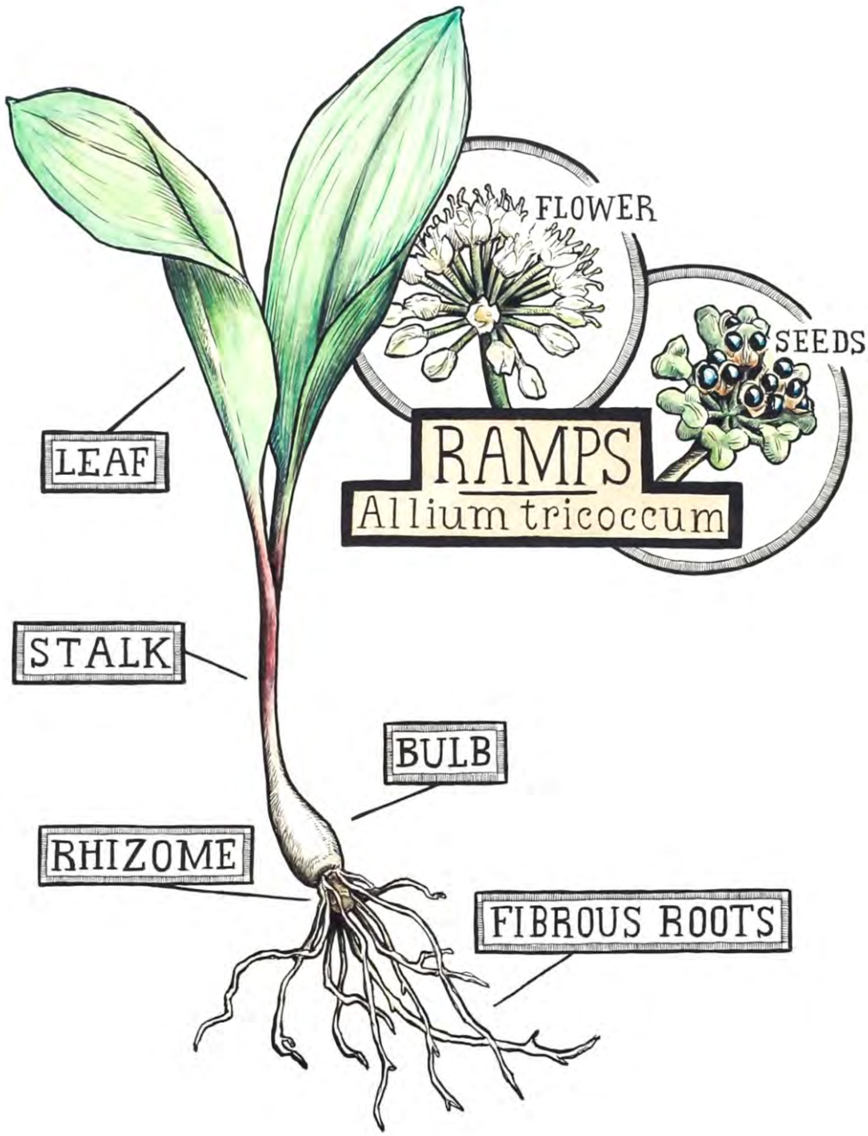
If the goal of labeling programs like FGV are to help draw attention to forest farmed products in the marketplace and distinguish them as a better and more sustainable alternative to wild-harvested materials, then it is important to define what "sustainability" means in the forest farming sector. Sustainability is an ambiguous term, and it can mean different things to different people. To some, simply cultivating species that are commonly collected from the wild and helping to reduce pressure on wild populations satisfies the criteria for being sustainable. To others, this may also mean accounting for the amount of water used to grow and process a crop, the energy used to dry the products, the type of fuel used to power equipment, and the wages paid to employees. While these elements are not specifically audited under the FGV program, forest farmers should consider how these types of environmental and social accounting can be incorporated into their management and/or business plans and how they can contribute to sustainable and regenerative models of production that can further distinguish and define the forest farming sector.

Chapter 3

Cultivation Guides

Ramps

Allium tricoccum
Allium burdickii
(Amaryllidaceae)



Overview

There are two species of ramps (*Allium tricoccum* and *Allium burdickii*) commonly found in the forests of eastern North America. These species are similar in physical appearance and flavor profile and will be simply referred to as "ramps" throughout this publication. Ramps are one of the first forest herbs to emerge in the spring and are highly sought after for their pungent garlic-like flavor. Ramps typically emerge several weeks before the leaves fully develop in the forest canopy and take advantage of the high amounts of sunlight that reach the forest floor. With plenty of early spring sun, plants grow rapidly from April to May and build up energy reserves in the bulb to fuel growth later in the season. Leaves and bulbs can be harvested from March to May depending on geographical location (Chamberlain et al., 2014), with plants reaching peak flavor and tenderness by mid to late April.

History

Historically, ramp populations were relatively abundant and were utilized as both food and medicine by indigenous North Americans and early European migrants. Many European settlers were already familiar with ramps when they came to North America, which were very similar to the "ramsons" (*Allium ursinum*), a Eurasian relative of *Allium tricoccum* (Edgar et al., 2012). As one of the first edible greens to emerge in spring, ramps were seen as a source of fresh vitamins and minerals after a limited winter diet, and the leaves were consumed as a spring tonic and blood purifier (Cavender, 2006). The leaves and bulbs were also used as an emetic, laxative, cold remedy (Small, 2013) and de-wormer (Cavender, 2006).

Ramp populations are not as abundant as they once were, largely due to overharvesting and the loss of suitable forest habitats (Ritchey and Schumann, 2005). While the rise in popularity of ramp festivals in the Appalachian region has put pressure on wild populations, the increased demand for ramps in high-end restaurants and in large metropolitan markets, such as New York City, Chicago, Seattle, and

Washington, D.C., has also contributed to increased harvest pressure on wild populations (Schreibstein, 2013).

Life Cycle

Ramp bulbs begin to elongate and unfurl their first leaves in early March as soil temperatures reach approximately 45°F - 50°F. By taking advantage of available sunlight, plants grow rapidly and reach at least 2-3 inches of growth by the beginning of April (Facemire, 2009). By mid-April, both the leaves and bulbs will have increased significantly in size and are considered to have peak flavor and tenderness at this stage of development. Plants are considered fully mature by mid to late May, and the leaves begin to discolor and turn yellow as plants begin to shift to the reproductive stages of development. By the time the flower stalk begins to emerge from the bulb in July, the leaves have completely disintegrated and are no longer visible (Nantel et al., 1996).

The white umbel of flowers borne on the flower stalk begins to bloom by late July (Nault and Gagnon, 1988), and the seeds will continue to develop through August, before fully ripening in September. Mature seeds, which resemble shiny black BB's, are fully formed and ready to harvest by mid-September. Seeds will persist on the stalk for several weeks to months until they naturally fall from the plant or are shaken loose by wind, rain, or snow. Ramp seeds exhibit a complex "double-dormancy" and require an 18-month period of stratification before they will germinate. Stratification is a process where seeds are exposed to the natural fluctuations of seasonal temperatures, which provide environmental cues that break seed dormancy and stimulate germination. Typically, with this type of dormancy, warming

temperatures during the spring and summer months break root dormancy, and cold temperatures during the following fall and winter months break shoot dormancy (Davis and Greenfield 2001).

As winter approaches, ramp bulbs enter a period of dormancy where active growth ceases until the following spring. During the winter months bulbs actually decrease in size and weight by shedding the outer-most layers of the bulb that were formed during the previous growing season. By mid-February the outer layers have been completely shed, and the plants are ready to start the growth cycle over again (Facemire, 2009).

Reproduction

Ramps have a long pre-reproductive period and do not typically become reproductively mature until after six or seven years of growth. Ramps are capable of both sexual (seed) and asexual (clonal) modes of reproduction, but evidence suggests that as populations increase in size and density, most reproduction occurs asexually via bulb division (Jones, 1979). Even though ramps tend to produce plenty of seeds, high levels of seedling mortality are common due to limited seed dispersal and high levels of competition between seedlings and plants already established within the population (Nault and Gagnon, 1993). Due to the compounding effects of limited dispersal and competition, only about 4% of ramp seedlings survive to three years old when they germinate within their parent population (Nault and Gagnon, 1993). For the purposes of forest farming, seedling survival can be significantly increased by simply collecting seeds and sowing them in a new location where they are free from competition.

Pollination

Ramp flowers are typically pollinated by a variety of small flying insects but are also capable of self-fertilization. Several species of bees have been observed visiting ramp flowers, including sweat bees (*Dialictus* spp.), masked bees (*Hylaeus* spp.), honeybees, bumblebees, mason bees, and other solitary bees (Hilty, 2017).

Seed Dispersal

Ramp seeds are primarily dispersed by gravity and simply fall from the seed stalk after ripening. Although, observational studies have shown that deer mice (*Peromyscus maniculatus*) (Nault and Gagnon, 1993), ants, and other insects (Facemire, 2009) occasionally collect and disperse ramp seeds as well.

Ramp Cultivation

Site Selection:

Ramps are considered a highly adaptable species and are capable of growing under a variety of habitat conditions. From our introductory discussion about site selection in Chapter 1, we know that the best growing sites are typically located on north, northeast, and east facing aspects. Within these aspects, select sites with a mature canopy of mixed hardwood trees that provide approximately 60%-80% shade to the forest understory and well-drained soils that are rich in organic matter and have a pH ranging from 4.7 to 6.7 (Bernatchez et al., 2013). Unlike the other species featured in this publication, ramps have a relatively high tolerance for soil moisture and are commonly found growing in forested bottomlands and other semi-riparian areas. These habitats should not be overlooked as potentially viable production sites but should be closely evaluated to ensure that the essential habitat criteria are met.

As previously discussed, the presence of companion and indicator plants can also be used to identify suitable growing sites. Species that are commonly found growing in association with ramps or prefer similar habitat conditions include, but are not limited to, tulip poplar, sugar maple, basswood, sycamore, elm, birch, trillium, cut-leaf toothwort, wood nettle, black cohosh, ginseng, bloodroot, blue cohosh, trout lily, and bellwort (Davis and Greenfield, 2001). Keep in mind that suitable production sites can also be found on south or west facing micro-sites where adequate moisture and shade are maintained.

Site Preparation:

Prepare the site for planting by following the guidelines for wild-simulated site preparation discussed in Chapter 1. Preparations will include removing large sticks and debris that will interfere with your rake; pruning or removing small understory trees, shrubs, or branches to improve air flow and reduce competition; and manually removing non-native invasive species.

Planting Seeds:

To plant ramp seeds using the wild-simulated method, simply rake back the leaf litter on the forest floor to expose a 4'-5' wide strip of soil. Make the strip as long as desired or as long as the site will allow (avg. 40'-50'). After the strip has been fully exposed, use a hard steel rake to scuff and loosen the top ¼" soil. Sow seeds at a rate of 7-10 seeds/sq. ft. until the strip is fully seeded. After the bed has been seeded, move uphill to start a second row, and rake the leaves downhill to cover the previously seeded bed. Once the seeds have been covered with leaves, gently walk across the bed to help press the seeds into the ground (Davis and Greenfield, 2001). Repeat the process until the site is fully planted or until you run out of seeds.

Seedlings develop best when sown outdoors in high-quality growing sites with fertile, well-drained soils. Sites with good soil texture and adequate moisture enable plants to develop healthy root systems, which can penetrate into the soil 6 inches or more. Seeds that are sown in seeding flats should be transplanted outdoors soon after the roots begin to develop to ensure that the root system does not become constricted and suppressed. If transplanting is not done properly and with care, significant transplant shock or mortality may result.

Planting Bulbs:

Ramp bulbs are best planted in the spring prior to breaking dormancy and beginning their seasonal growth cycle. Depending on location, plant bulbs from March to April using a small mattock, soil knife, hand trowel, or other appropriate digging tool. Dig individual holes or planting furrows approximately 3” deep. Place the bulbs in the hole/furrow, ensuring that the fibrous roots are spread laterally and pointing down and leaving approximately ¼” of the bulb tip above the surface of the soil. Then refill the hole/furrow with soil, gently repacking the loosened soil around the bulb. Once the soil is back in place, cover the planted bulbs with approximately 2” of leaf litter.

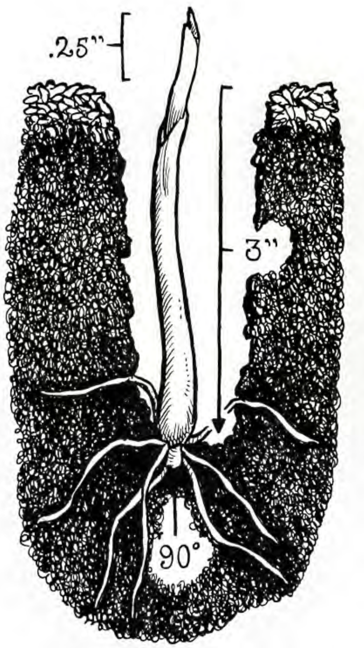


Figure 2.

Bulbs should be sub-divided and transplanted when 8-10 bulbs appear in a clump in order to reduce competition and maintain active growth. When dividing bulbs, transplant them in late summer after the seeds have been collected or in the early spring as the leaves first appear. Replant the bulbs to their original depth, and water immediately if possible, especially if natural precipitation is not expected.

Seed Collection and Storage

Approximately four to six weeks after flowering, the small, three-lobed seed capsules begin to develop. The capsules, measuring approximately ¼ inch long, remain green as the seeds develop through the summer months and turn a straw/tan color as they ripen in the fall. Beneath the hull of the capsules there will be 1-3 small black seeds, measuring approximately 1/8 inch in diameter. Throughout most of their native range, ramp seeds will ripen and be ready to collect by mid to late September.

Freshly collected ramp seeds can be planted directly throughout the fall months or can be stored in a cool, dry place for planting the following year (Facemire, 2009). If seeds are not planted after collection, make sure excess moisture has dissipated from the seeds before sealing in a bag or jar. An easy way to remove excess moisture is to place freshly collected seeds in a paper grocery bag for 24-48 hours or until they become papery dry before transferring to a storage container. If seeds are not dried adequately, mold and spoilage will occur. When properly dried and stored under ideal conditions, seeds can remain viable for up to three years, but germination rates can decline during prolonged storage.

Crop Maintenance

Minimal maintenance will be needed if proper site selection and planting guidelines are followed. Ramps are a naturally hardy and disease resistant species, making most of the interventions common to other forest farmed crops unnecessary. Plantings that are installed in raised beds, gardens, or other unnatural settings may require additional maintenance, such as weeding, irrigation, and annual additions of hardwood leaf mulch. Additions of leaf mulch in both natural and unnatural settings can help to improve soil nutrition, increase moisture retention, facilitate weed suppression, and provide added insulation during the winter months.

Pests and Disease

Septoria leaf spot is a fungal disease that can affect the foliage of ramp plants. *Septoria* is a largely cosmetic and non-lethal pathogen that causes small circular blemishes to develop on the leaves causing them to discolor. If possible, the infected vegetation should be removed from the growing site to help limit the spread of the disease.

Harvest Methods

Ramps are typically harvested by digging up and removing the ***whole plant*** from the growing site. Whole plant removal is considered the most aggressive harvest method and ultimately results in the destruction of the plant. Whole plant removal should be accompanied by a robust seed collection and replanting protocol that helps to facilitate the recovery of the population. One strategy for increasing the sustainability of whole plant harvesting is to target dense "clumps" for whole plant removal. By targeting the clumps, the large mature plants can be removed, while the small juvenile plants can be replanted and will continue to grow.

Figure 3.

The ***cut-stalk method***, also known as the *"snap" method* (Institute for Sustainable Foraging, 2017), is a non-destructive harvest technique that enables the removal of all leaf material and part of the stalk, while leaving the bulb and roots undamaged and intact. To harvest ramps using the cut-stalk method, insert a knife just below the surface of the soil (approx. 1"-1.25") and cut the stalk just above the bulb (Figure 3). With this method it is important not to insert the knife too deeply and risk cutting into the bulb, which may impact the ability of the plant to regrow the following season or result in unintended mortality.

Figure 4.

The ***leaf-only*** harvest method is the least-intensive of the three methods described in this publication and can be a viable alternative for certain producers. As illustrated in Figure 4, leaf-only harvesting simply involves the removal of one-leaf (for two-leaf plants) or two-leaves (for three-leaf plants) (United Plant Savers, 2016), and help ensure that plants will re-grow the following season. Leaf-only harvests can be utilized early in the cropping cycle while waiting for plants to fully mature or as a sustainable stand-alone technique.

Harvesting Guidelines

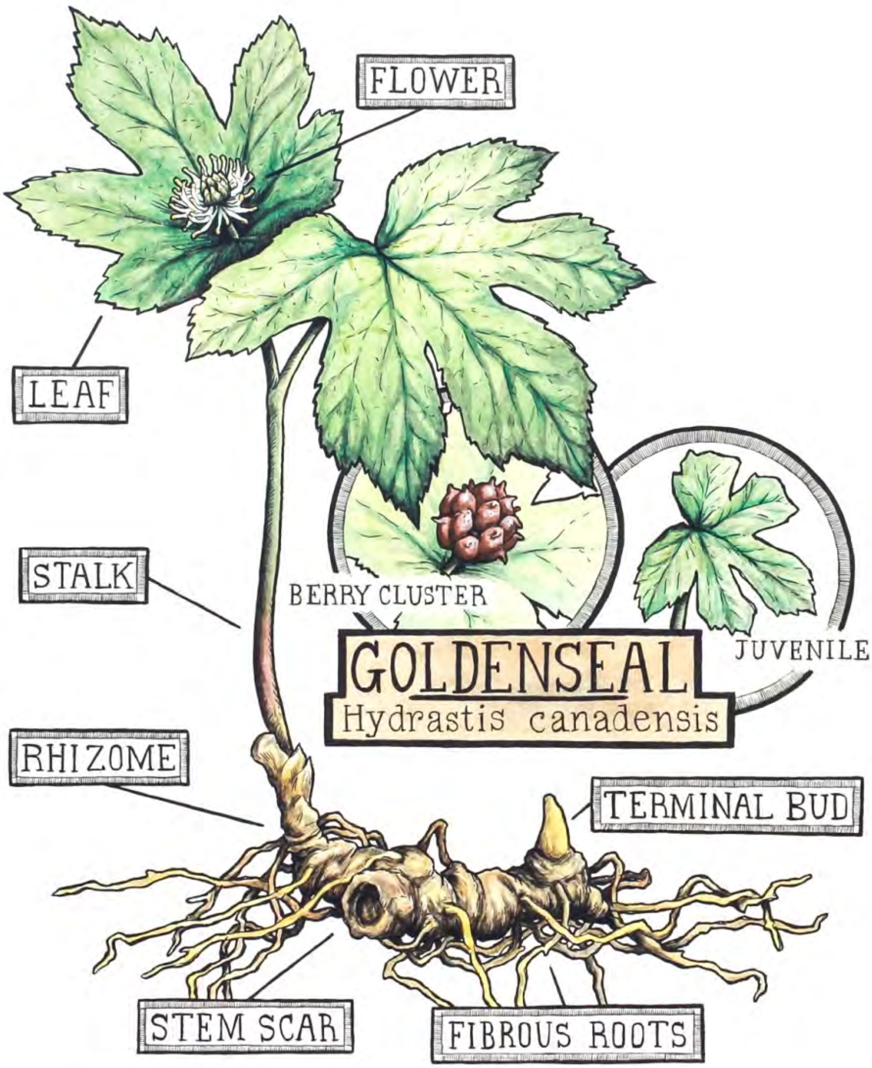
Establishing sustainable harvesting guidelines can be challenging and will vary between individual populations and growing sites. Based on available research on the harvest and recovery of wild ramp populations suggests that no more than 10% of a population should be removed in a given year, and harvests should be limited to only once per decade to ensure adequate time for population recovery (Rock et al., 2004). Therefore establishing multiple patches and appropriate harvest cycels is recommended.

Washing and Post-Harvest Handling

Ramps should be washed and refrigerated as soon as possible after harvesting to avoid contamination by potential food borne pathogens. Allium species can potentially harbor *Clostridium botulinum*, a soil-dwelling organism that can cause botulism, a potentially deadly food borne disease (Block, 2010). For this reason, adequate washing to remove soil particles and prompt refrigeration are strongly recommended. To wash large quantities of material, spread plants on a wire-mesh washing rack and spray the bulbs with a light to medium pressure hose. If any residual dirt is left on the leaves rinse under a stream of low pressure water to avoid bruising or damaging the leaf material. Small quantities of material can be washed using the same technique described above or can be washed in a small sink or basin.

Goldenseal

Hydrastis canadensis
(Ranunculaceae)



Overview

Goldenseal is considered to be one of the most at-risk medicinal plants in the United States and is estimated to be at a high risk of extinction throughout its native range (Oliver, 2017). Goldenseal is typically found growing in densely clustered patches (Burkhart and Jacobson, 2006) on forested slopes, along stream banks, and in rich open woodlands from southern Ontario to north Georgia (Sievers, 1949; McGraw et al, 2003). For forest farmers, goldenseal is well suited as a stand-alone crop or as a companion plant within a mixed-species production system. Goldenseal has a high natural resistance to fungal pathogens and may help to reduce disease outbreaks when planted as part of a mixed-species polyculture. For example, it is common for ginseng growers to interplant goldenseal as a natural defense against the spread of fungal pathogens.

History

Goldenseal has traditionally been harvested for the medicinal properties of its rhizome (Foster, 1991) with the first documented use by European settlers recorded in 1769 (Persons and Davis, 2005). Traditionally, goldenseal has been used to treat a variety of applications, including as a strengthening tonic, stomachic, sore throat gargle, eye wash, and topical treatment for cuts, sores, ulcerations, and infections (Van der Voort, 2003; Pengelly et al., 2012). Noted declines in the abundance of wild populations, largely due to habitat loss and overharvesting, resulted in goldenseal being listed on Appendix II of the Convention on the International Trade of Endangered Species (CITES) in 1997. As a CITES regulated species, the U.S. Fish and Wildlife Service monitors all exports of goldenseal from the United States in an attempt to ensure that the harvest and trade of the species is sustainable (Robbins, 2000). In response to continued population declines, conservation advocates have suggested that a moratorium on the harvest and sale of wild goldenseal should be implemented to help protect the viability of remaining populations. Similarly, industry stakeholders have initiated efforts to research and develop sustainable harvesting, management, and cultivation guidelines that will help ensure the long-term survival of the species.

Life Cycle

Goldenseal's life cycle can be separated into three distinct stages of development: the seedling stage, the juvenile stage, and the reproductive stage. Following seed germination, plants can remain in the *seedling* stage of development for 1 to 2 years depending on the quality of the growing site. Seedlings do not develop a true leaf during the first year of growth, but instead persist with two small, round leaf-like cotyledons that may be easily overlooked. After 2 to 3 years of growth, plants reach the *juvenile* stage of development, which is marked by the development of a single palmately-lobed leaf (Burkhart and Jacobson, 2006). Plants will generally persist in the juvenile phase for 1 to 2 years before becoming fully mature. After 4 to 6 years of growth, plants will finally become sexually *reproductive* and will develop a forked stem with two leaves and a small white flower. The showy, white flower blooms almost immediately after the plant emerges and begins to unfurl its leaves in April. Like many woodland herbs, goldenseal flowers are pollinated by small bees and syrphid flies but are also capable of self-fertilization (Chafin, 2007). The fruit, a raspberry-like drupe, matures through the summer months, turning from green to red before ripening in mid- to late July (Van der Voort et al., 2003). The seeds, which resemble shiny-black BB's, can exhibit single or double dormancy, with most seeds germinating the first spring if stratification requirements are met (Persons and Davis, 2005; Albrecht and McCarthy, 2011).

Reproduction

Although goldenseal can reproduce via seed production, most natural population growth occurs through clonal propagation (Van der Voort et al., 2003; Burkhart and Jacobson 2006) where adventitious buds form along the fibrous roots and eventually swell to emerge as a new plant (Albrecht and McCarthy, 2006). Clonal growth can result in large, dense populations with up to 100 stems documented growing within a 3’ x 3’ plot (Gagnon, 1999).

Pollination

Goldenseal is primarily pollinated by small “sweat” bees of the genera *Dialictus* and *Evylaeus*, as well as syrphid flies and some larger bee species (Sinclair and Catling, 2000). Goldenseal is also capable of self-fertilization when conditions for pollination are unfavorable (*e.g.* cold, rain, etc.) or when cross-pollination is unsuccessful (Chafin, 2007).

Dispersal

The quick disappearance of ripe berries, their red color, and their position on top of the plant’s leaves indicates that birds may be the fruits’ primary consumers and dispersers (Eichenberger and Parker, 1976), but this has not been fully investigated to date. In addition to birds, a wide variety of animals and insects have been observed consuming goldenseal fruits and/or seeds, including wild turkey, mice (Philhower-Gillen, 2015), deer, chipmunks, squirrels, ants, raccoons, and possum.

Seed Collection and Stratification

Starting goldenseal plantings from seed is considered a less consistent method of propagation (Follet and Douglas, 2005), but you can increase the chances of success by following a few key guidelines. For best results, collect seeds as they ripen in July/August, and sow them as soon as possible. By sowing immediately after collection, the seeds are naturally exposed to the warm late-summer temperatures that are required to break seed dormancy and enable them to germinate the following spring (Albrecht and McCarthy, 2011). Research suggests that if seeds do not experience these late-summer temperatures, they are more likely to exhibit an extended dormancy, and germination will be delayed until the following year (Albrecht and McCarthy, 2007).

If desired, goldenseal seeds can be collected and stratified under controlled conditions and then stored for planting the following year. To prepare seeds for stratification, loosen the seed from the pulp by mashing the berries, and then soak them in water until the pulp begins to separate from the seed (Burkhart and Jacobson, 2006). After 24 hours, drain off the water and pulp fragments, while retaining the seeds. Rinse the seeds with a moderate pressure hose or faucet and rub them with your fingers to remove any remaining pulp (Albrecht and McCarthy, 2007). Once cleaned, the seeds can be stored in a refrigerator or buried in a stratification box for 2-3 months where they will be exposed to the warm/cold temperature fluctuations required to break seed dormancy. Research suggests that seeds should not be kept in stratification for more than 90 days, or delayed germination can result (Albrecht and McCarthy, 2007).

Goldenseal Propagation

Propagation from Seeds:

After collecting or stratifying, simply plant seeds ½”-¾” deep in a prepared nursery bed or shallow planting furrow and re-cover with soil and 1”-2” of leaf litter. Seeds can also be planted using the wild-simulated technique previously described in Chapter 1, where seeds are broadcast on the surface of the soil (5-7 seeds/sq. ft.) and then covered with leaf litter. If seedlings have been propagated in a nursery bed, they should be transplanted to a permanent location after two years growth (Cech, 2002).

Propagation from Rhizome Cuttings:

Goldenseal is most commonly propagated by subdividing mature rhizomes into smaller rootlets that can then be replanted. Mature rhizomes should be divided into ½”-1” inch long pieces, as illustrated in figure 5. Each cutting should have healthy fibrous roots and a dormant bud if possible (Greenfield and Davis, 2004). Rhizomes and fibrous roots typically have several dormant buds, some of which may be imperceptible to the naked eye. If a rootlet has no visible bud, it is possible that one may develop after the rootlet is planted.

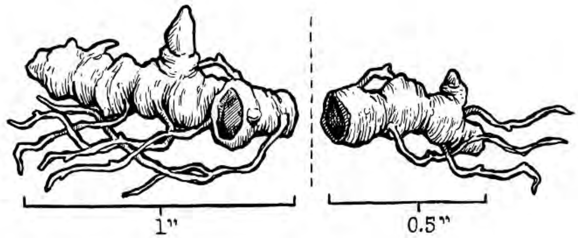


Figure 5.

Propagation from Fibrous Root Cuttings:

In addition to whole rhizome cuttings, goldenseal can also be propagated by using portions of the fibrous root system. This propagation method mimics goldenseal's natural ability to repropagate from root fragments that are severed during the harvesting process (Burkhart and Jacobson, 2006). The fibrous roots, which tend to grow prominently along the entire length of the rhizome, are covered with small dormant bud scales that, if given enough time, can develop into a new plant and root system. To propagate new rootlets from fibrous root material, simply cut the roots into ½"- 1" pieces, and plant them ½"- 1" deep in a prepared nursery bed. Given the small size of the propagule and the lack of well-developed buds, it may take up to two years for plants to fully emerge.

Site Selection

Goldenseal is typically found growing on north, northeast, and east facing aspects under a mature forest canopy that provides approximately 60%-80% shade (Davis and Persons, 2014). At higher elevations (< 3,400 ft.) growers have reported that goldenseal can tolerate as little as 45% shade and still maintain satisfactory growth. Within these baseline conditions, goldenseal prefers sites with well-drained soils that are rich in organic matter yet maintain a slightly acidic soil pH (5.5.–6.5) (Greenfield and Davis, 2004). As previously discussed, the presence of certain companion plants and other indicator species can also be used to identify suitable growing sites. Species that are commonly found growing in association with goldenseal include, but are not limited to, tulip poplar, sugar maple, basswood, black walnut, red oak, slippery elm, white ash (Burkhart and Jacobson, 2006), trillium, black cohosh, ginseng, mayapple, and bloodroot (Persons and Davis, 2005).

Site Preparation and Planting Using Wild-simulated Method

Site Preparation:

To prepare the growing site for a wild-simulated planting, start by removing any fallen branches, rocks, or other debris that will interfere with the planting process. If necessary, selectively remove small trees and shrubs or prune low hanging branches to improve airflow and optimize light conditions. If invasive species are present, they should be manually removed and/or controlled prior to planting.

Planting Wild-Simulated Seeds and Rhizomes:

Whether you are starting with seeds or rootlets, goldenseal is best planted during the late summer and fall seasons. To plant seeds using the wild-simulated method, simply rake back the leaf litter on the forest floor to expose a 4'-5' wide strip of bare topsoil, and then scuff the soil with a hard steel rake to slightly loosen the top ¼" of material. Once the planting bed is prepared, broadcast seeds at a rate of 5-7 seeds/sq. ft. until the bed is fully planted and then re-cover with leaf litter. After the leaf litter has been redistributed across the bed and the seeds are sufficiently covered, walk across the planted area to help improve seed to soil contact. Seeds can also be planted ½"- ¾" deep in a shallow planting furrow if the rake and scatter method does not meet your needs.

To plant rootlets, start by raking the leaf litter off of the planting site to expose a 4'-5' wide strip of soil. Once the planting strip has been exposed use a mattocks or sturdy garden hoe to dig a planting furrow or holes for individual rootlets. Regardless of which approach you decide to use, furrows and/or holes should be dug approximately 2"-2.5" deep to ensure that there is an adequate amount of soil to sufficiently cover the rootlet and terminal bud. After the hole/furrow has been prepared, plant rootlets 2" deep with the fibrous roots spread laterally and the terminal bud approximately ½"- ¾" below the surface of the soil. Once the rootlets have been properly positioned, backfill the hole/furrow with soil and firm around the rootlet, and then re-cover the planted area with 1"-2" of leaf litter.

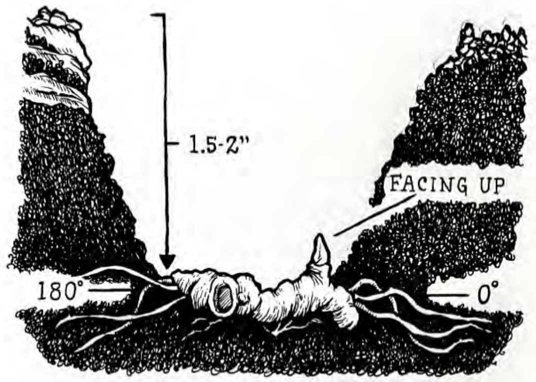


Figure 6.

If seeds or rootlets are leftover at the end of the season, plant them as soon as possible the following spring (March - April) to ensure the best chances of survival.

Site Preparation and Planting Using the Woods-Cultivated Method

Site Preparation:

As we have previously discussed, woods-cultivated production systems are more intensively managed and will typically require more extensive site preparations. As previously described in the wild-simulated section, remove fallen branches and other debris that will interfere with the planting process. Since the woods-cultivated method relies on the development of tilled and cultivated planting beds to optimize growth, more intensive removal and management of existing vegetation will be required. In order to prevent unnecessary damage to surrounding vegetation, mark the boundaries of your planting beds prior to removing any trees, shrubs, or other vegetation from the site. Beds can be of any size and dimension but should be narrow enough to allow for easy maintenance and management (approx. 4'- 5' wide). Once the beds have been marked, remove, thin, or prune competitive and suppressive vegetation within the planting area to help facilitate bed development, increase airflow, and optimize light conditions. After the vegetation has been removed, apply any necessary soil amendments, such as pelletized gypsum, sand, rock phosphate, or composted leaf mulch, and then shallowly till the beds with a heavy-duty tiller or tractor to loosen the top 3"- 6" of soil.

Planting Woods-Cultivated Seeds and Rhizomes

Once the planting beds have been prepared, use a hoe or similar tool to make shallow planting holes approximately 2"- 3" deep throughout the beds. The holes should be spaced 6"- 8" within rows, and rows should be spaced 8"- 10" apart. Wider row spacing (*e.g.* 12") may be needed for longer cropping cycles. After the holes have been established, plant rootlets approximately 2" deep with the bud ½" below the surface of the soil. After the bed has been planted, recover the with 1"-2" leaf mulch.

In woods-cultivated production, seeds are typically sown in a prepared nursery bed, and then the seedlings are transplanted to a permanent location after 1-2 years of growth.

Crop Maintenance

Maintaining the habitat conditions that you have either selected or created is an important part of any forest farming operation. The amount of maintenance required will vary based on the production methods used, the extent of site modifications prior to planting (*e.g.* vegetation removal, tilling, etc.), the occurrence and frequency of disease, and similar production variables.

One of the primary advantages of wild-simulated plantings is that they are relatively self-sufficient and typically require less upkeep and maintenance than their woods-cultivated counterparts. Common maintenance activities for wild-simulated plantings include, but are not limited to, regularly inspecting plantings for signs of disease, predation, and mortality; pruning and/or repruning competitive vegetation to maintain airflow and optimal light conditions; and periodically trapping/baiting rodents and other pests when crop damage is observed. In addition to the previously described activities, woods-cultivated plantings will likely require annual weeding to prevent the establishment and/or reestablishment of competitive vegetation within the tilled beds. Moles and voles also like to forage in loosely tilled soils and may require regular trapping/baiting to prevent crop damage.

Pests and Disease

Goldenseal is considered to be a relatively hardy and disease resistant species but is still susceptible to a variety of pests and pathogens, including botrytis leaf blight, fusarium wilt, root rot disease, and root knot nematodes as well as slugs, moles, and voles (Greenfield and Davis, 2004). The first line of defense in disease prevention is to select and maintain the habitat conditions that support healthy plantings. One of the primary factors that contribute to the development and spread of fungal pathogens is planting density; thus, as the density of your plantings increase, so does the potential for disease. Keep in mind that density can refer to the conditions within a single bed, as well as the conditions between beds. By developing dispersed plantings rather than large consolidated beds, the spread of pathogens between plantings (Burkhart and Jacobson, 2006) and the potential for large-scale crop damage can be reduced.

Harvesting

Goldenseal roots are harvested in the fall of the year as the plants begin to enter winter dormancy. If possible, wait until late September/October when the leaves begin to turn yellow and die back for the season. As the leaves begin to fade, medicinally active constituents are transferred to the root system, which increases the medicinal quality of the final product (Douglas et al., 2010; Burkhart and Zuiderveen, 2019). Aside from medicinal quality, there are other benefits to delaying harvests until the fall. Research examining the relationship between the timing of harvest and population recovery has shown that fall harvested populations recover faster than those harvested during the summer months (Sanders and McGraw, 2005; Albrecht and McCarthy, 2006). Growers have also reported that fall harvested roots have a better fresh to dry ratio, which can reduce the time required to fully dry the roots.

As a forest farmer it may not always be feasible to delay harvesting until plants begin to make this transition, especially if large quantities of roots need to be harvested and processed in a short amount of time, or when you need to adhere to the timeline of a specific customer. If harvesting cannot be delayed, at a minimum, plants should not be harvested until the seeds have been collected or dispersed, and the reproductive cycle has been completed.

Depending on the quality of the growing site, plants that were propagated from rhizome cuttings or rootlets typically reach harvestable size after 3 to 4 years of growth (Burkhart and Jacobson, 2006), and plants that were propagated from seed typically reach harvestable size after 5 to 7 years of growth (Greenfield and Davis, 2004). Keep in mind that these age ranges may vary based on growing site quality and other environmental factors.

Washing

All root material should be adequately washed to ensure that it is free from dirt and debris. Excess dirt remaining on the roots can contribute to elevated levels of bacteria, and can decrease the value of the final product. To wash small and medium-sized batches of material, briefly soak the roots in a tub of water to soften and loosen any foreign debris. Then spread the roots on a wire mesh screen and spray with a medium pressure hose to rinse clean. Some roots may need to be broken into smaller pieces in order to dislodge all dirt, rocks, roots, and other debris. The same technique can be used to wash large quantities of material, but it may be more efficient and cost-effective to use a commercial root washer or similar device. Whether soaking the roots in water or washing them with a hose, make sure the contact with water is as brief as possible to prevent the loss of desired alkaloids, specifically berberine and hydrastine. Alkaloid leaching from prolonged washing will not only decrease the quality of the roots but can also negatively affect the value of your final product. A simple way to monitor this is to observe the color of the wash water. If the water is turning yellow, then alkaloids, specifically berberine, are being leached from the roots.

Drying

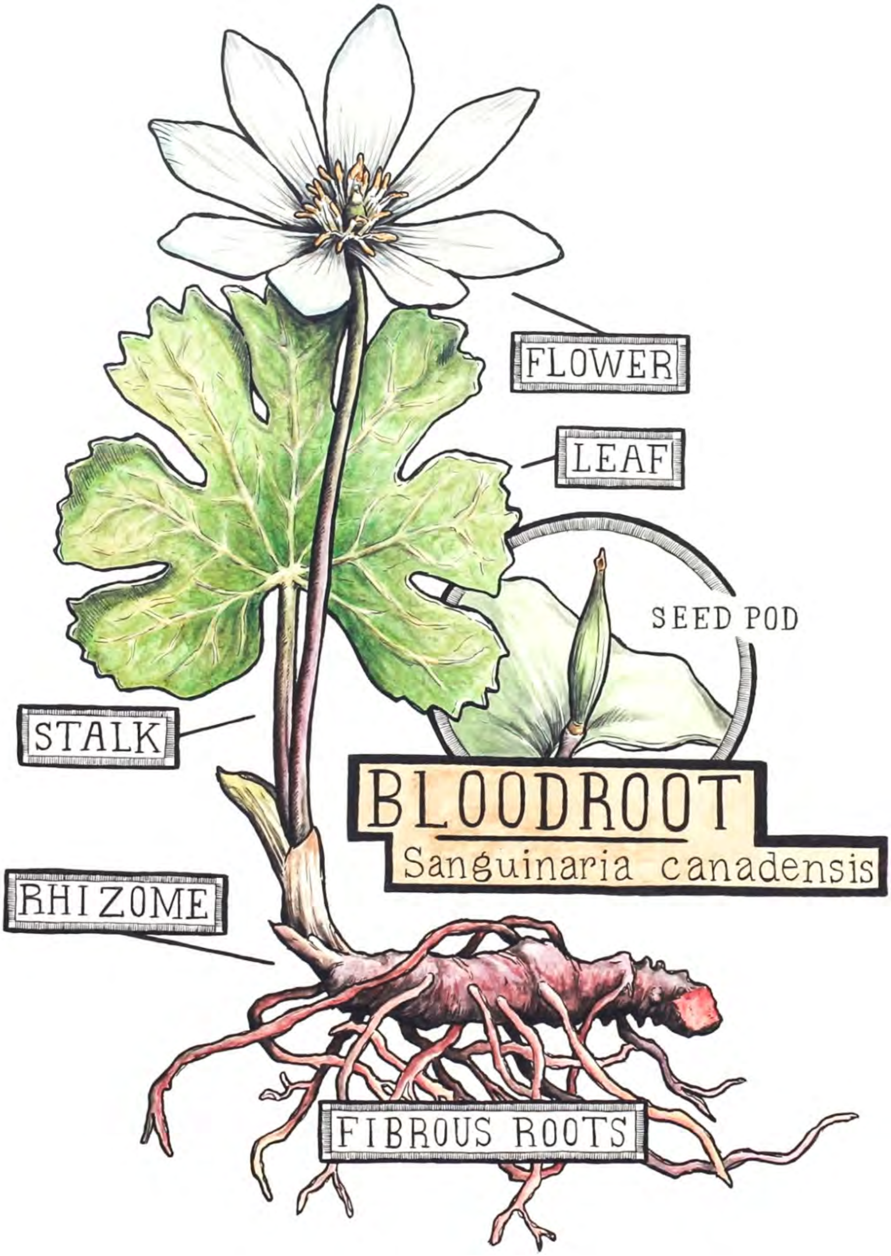
Roots must be properly dried in order to preserve product quality and ensure the integrity of the product during long-term storage. To dry, spread roots evenly on a wire mesh screen in a dark, well-ventilated area with forced airflow (*e.g.* fan) where temperatures can be maintained at 85-95°F. In humid locations temperatures as high as 130°F may be needed to fully drive off excess moisture from the roots (Davis, 2016). The roots should be regularly inspected for any signs of mold or spoilage, and if detected, the infected pieces should be removed from the room. Maintaining adequate airflow will help to eliminate moisture on the surface of the root and prevent the onset of mold development facilitating a faster, more even drying process. During the drying process, roots will lose approximately 70% of their weight depending on the original moisture content, and the color will darken slightly, turning from yellow to light brown. While the exterior of the root will darken, the inside of the root should maintain a bright and vibrant yellow color. To determine when the drying process is complete, select several average-sized roots from the batch, and then break them in half. The roots should snap cleanly when fully dried but should not be overly brittle.

Post-Harvest Handling

Follow all recommended guidelines described in the GAPC section.

Bloodroot

(*Sanguinaria canadensis*)
Papaveraceae



Overview

Bloodroot is one of the most iconic and well-known spring wildflowers found in the deciduous forests of eastern North America. As an ephemeral species, bloodroot is one of the first plants to emerge and bloom in the spring, thus ensuring sufficient time for plants to capture and store energy while there is abundant sunlight available on the forest floor (Hayden, 2005). The crimson-colored rhizome, which produces a blood-red sap when cut, contains relevant concentrations of eight medicinally active alkaloids (Croaker et al., 2016) and has been used both commercially and eclectically in toothpastes, salves, and other preparations (Persons and Davis, 2014). Bloodroot is capable of developing dense populations through both rhizome branching and seed production (Furgurson et al., 2012) with ants being the primary seed dispersers (Predny and Chamberlain, 2005). Bloodroot seeds have a specialized appendage called an elaiosome, which serves as a lipid rich food source for the ants (Pengelly and Bennett, 2011). The ants gather the seeds, take them to the nest, eat the elaiosome, and then discard the seeds in old galleries and refuse tunnels where they can germinate in a relatively rich and protected environment (Predny and Chamberlain, 2005). Commercial demand for bloodroot continues to put pressure on wild populations as historically low market prices have made cultivation cost prohibitive (Furgurson et al., 2012; Burkhart and Jacobson, 2009), underscoring the need to develop value-added marketing initiatives (*e.g.* Forest Grown Verification), direct marketing opportunities, and other mechanisms to support intentional and sustainable production.

Site Selection

Bloodroot is typically found growing on north, northeast, and east facing aspects under a mature forest canopy that provides approximately 50%-80% shade (Braly, 2007; Marino et al., 1997; Davis and Dressler, 2012). Within these baseline conditions, bloodroot prefers sites with well-drained soils that are rich in organic matter, thick leaf litter, and a slightly acidic soil pH (5.5.–6.5) (Davis and

Dressler, 2012; Pengelly and Bennett, 2011). If the site and/or soil are not well drained, bloodroot rhizomes will tend to rot. For this reason, selecting a gently to moderately sloped planting site can help facilitate drainage and improve the overall conditions for bloodroot cultivation. As previously discussed, the presence of companion plants and other indicator species can also be used to identify suitable growing sites. Species that are commonly found growing in association with bloodroot include, but are not limited to, tulip poplar, sugar maple, basswood, and magnolia (Braly, 2007) as well as spicebush, trillium, goldenseal, ginseng, and Jack-in-the-pulpit (Apsley and Carroll, 2004).

Site Preparation for Wild-Simulated and Woods-Cultivated Production

To prepare the growing site for a wild-simulated planting, start by removing any fallen branches, rocks, or other debris that will interfere with the planting process. If necessary, selectively remove small trees and shrubs, or prune low hanging branches to improve airflow and optimize light conditions. If invasive species are present, they should be manually removed and/or controlled prior to planting.

For woods-cultivated plantings, mark the boundaries of your planting beds to prevent damage to surrounding vegetation during the site preparation process. Beds can be made to any size and dimension but should be narrow enough to allow for easy maintenance and management (approx. 4’-5’ wide). Once the beds have been marked, remove, thin, or prune competitive and suppressive vegetation within the planting area. After the vegetation has been removed, apply any necessary soil amendments, and then shallowly till the beds with a heavy-duty tiller or tractor to loosen the top 3”- 6” of soil.

Propagation from Seed

Bloodroot seedlings can be propagated using multiple techniques, including sowing seed in a cold frame greenhouse, sowing in a prepared woodland nursery bed, or by sowing directly in a wild-simulated production site (Davis and Greenfield, 2006). Seedlings that have been established in a prepared nursery beds should be transplanted to a permanent location after two years' growth (Cech, 2002) and should reach harvestable size 5-7 years after transplanting (Davis, 2012).

Seeds can be collected from reproductive plants approximately 4-5 weeks after the flowers die-back (early to mid-June) and as the seed pod begins to fade from green to yellow. The narrow elliptical seed pods measure approximately 3" long and can contain twenty-five seeds or more. Bloodroot seed pods are spring-loaded and eject the seeds as they open (Croaker et al., 2016), making collection difficult if not timed properly (Davis and Dressler, 2012). For best results, collect whole pods as they approach maturity, being careful not to rupture the capsule. Cut the seed stalk as close to the ground as possible, so the seeds continue to receive support/nutrients from the remaining stalk, ensuring that they will fully mature. After collecting, seeds can be removed by hand as the pods dry, or they can be hung upside down in a paper bag with a thin layer of slightly damp sand or potting mix lining the bottom, where the seeds can be retrieved and sown. Maturing pods can also be covered with fine mesh or nylon bags that will catch the seeds as they are ejected from the pods (Persons and Davis, 2014).

Seeds should never be allowed to dry out and should be planted as soon as possible after collection (Davis and Greenfield, 2006). If properly handled and planted soon after collection, the seeds will stratify naturally and should germinate the following spring. It is possible that some seeds will exhibit an extended dormancy and will not germinate until the second spring following dispersal (Albrecht and McCarthy, 2011). Plant seeds approximately ¼"- ½" deep in a prepared woodland nursery bed or wild-simulated production site, and cover with 2" of leaf mulch (Albrecht and McCarthy, 2011; Davis and Dressler, 2012).

Propagation from Rhizome Cuttings

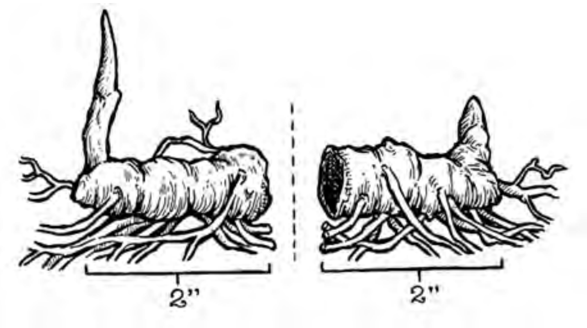


Figure 7.

Bloodroot is most commonly propagated by subdividing mature rhizomes. Rhizomes should be propagated in the fall of the year as the plants are entering winter dormancy, which is indicated when the leaves begin to yellow and fade. As illustrated in figure 7, rhizomes should be divided into 2” long segments, each with several fibrous roots and a dormant bud whenever possible. The presence of a viable bud has been shown to be essential to the growth and development of young rootlets. Davis (2012) and Nivot et al. (2008) reported that rootlets with a bud present at the time of planting had emergence rates of 89% and 95% respectively during the first growing season whereas 90% of rootlets without a terminal bud exhibited delayed emergence until the second growing season (Nivot et al., 2008).

Whole rhizomes and newly propagated rootlets are best planted in the fall but may also be planted in the spring if you have planting stock left over from the previous year. Plant rhizomes and rootlets approximately 2”-3” deep and spaced 6” apart (Persons and Davis, 2014). After planting, cover the area with 2”-3” of leaf litter.

Maintenance

Once established, plantings will require periodic maintenance, such as inspecting for signs of herbivory, disease, and mortality, as well as pruning or weeding to maintain optimal growing conditions. Deer, groundhogs, and turkey have all been reported to browse bloodroot flowers and/or foliage and can have a significant impact on seed production. Several diseases have also been found to impact bloodroot plantings, and a comprehensive disease management protocol is recommended in case an outbreak occurs. In order to encourage optimal growth, growers have reported that bloodroot plantings will benefit from an annual application of a low NPK fertilizer, micronutrient blend, and/or composted leaf mulch.

Pests and Disease

As with many other forest herbs that are brought under cultivation, bloodroot is susceptible to infection by a variety of fungal pathogens, which most commonly include leaf blights (*e.g. Alternaria* and *Botrytis*) and root rot diseases (*e.g. Pythium*) (Davis and Dressler, 2012; Persons and Davis, 2014). It is important to note that these diseases are not commonly observed in wild bloodroot populations, and typically arise in cultivated plantings when growing conditions are less than optimal, such as inadequate airflow and poor soil drainage or when plantings become concentrated and overcrowded (Davis and Dressler, 2012; Persons and Davis, 2014). If a disease outbreak does occur, remove blighted leaves and infected roots from the growing site, and spot treat the affected area with on organic fungicide once the pathogen has been accurately identified (Davis and Dressler, 2012). In addition to fungal diseases, slugs, deer, and turkey have been observed to defoliate or browse bloodroot foliage, which can reduce seed production, slow root growth, and contribute to decreased yields over time. Slugs can be controlled with beer traps or diatomaceous earth, but fencing will be required to fully exclude deer, turkey, and other browsers from planted areas (Davis and Dressler, 2012).

Keep in mind that not all insects are pests. As previously mentioned, bloodroot shares a symbiotic relationship with ants, which are the primary dispersers of bloodroot seeds. So, if ants are observed in bloodroot plantings, they should not be of concern to the grower.

Harvesting

Bloodroot is typically harvested in the fall of the year as the plant begins to enter winter dormancy but can also be harvested in the spring. Research has shown that the concentration of medicinally active alkaloids in the root are also at peak levels shortly after the flower has bloomed and the seed pod begins to develop. If medicinal potency and alkaloid content are important selling points for your customers, then spring harvesting may also be a viable option. If harvested in the spring, the active growing tip of the rhizome should be subdivided and replanted in order to accommodate for harvesting before the plant had the chance to complete its reproductive cycle.

Depending on how the plants were propagated (*e.g.* direct seed vs. rhizome), harvest roots after 4-8 years growth, taking care not to damage the root (Croaker et al., 2016).

Washing

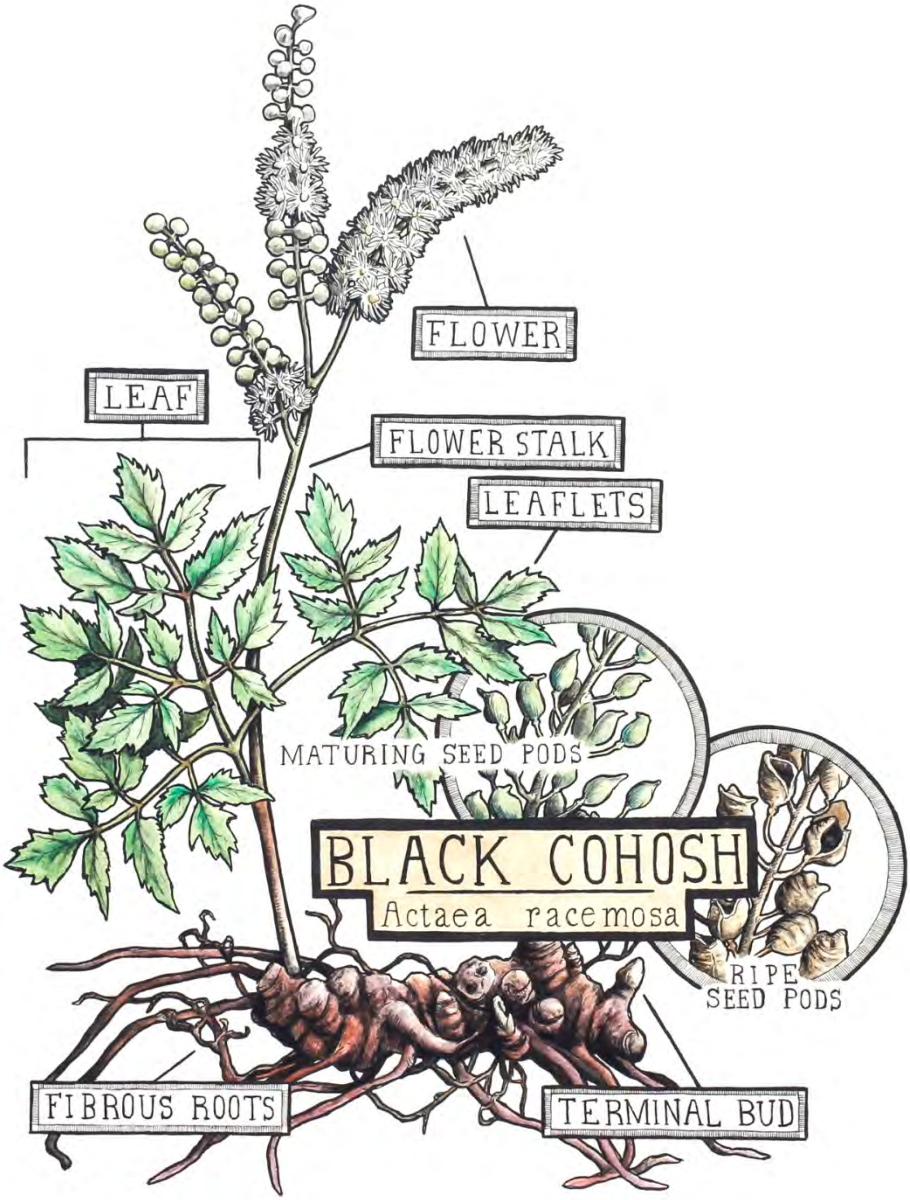
After harvesting, roots should be washed thoroughly to remove all dirt, debris, and foreign root material. Sometimes breaking the root may be necessary to fully dislodge all unwanted materials. Briefly soak roots in a bucket of water to soften the dried dirt and debris clinging to the root, and then spread the roots on a wire mesh screen, and spray with a medium-pressure hose. Mechanized or hand powered root washers can also be used and may be a better alternative for washing large volumes of root material (Davis and Dressler, 2012).

Drying

Roots must be properly dried in order to preserve product quality and ensure the integrity of the product during long-term storage. To dry, spread roots evenly on a wire mesh screen in a dark, well-ventilated area with adequate airflow where temperatures can be maintained at 85 - 95°F for 3-7 days, or until completely dried (Davis and Dressler, 2012). In humid locations, drying temperatures may have to be increased to fully drive off excess moisture from the roots (Davis, 2016), but should not exceed 105°F to preserve product quality. Larger roots can be cut or sliced into smaller pieces for more thorough drying and should not decrease the value of the roots, unless otherwise specified by the buyer. During the drying process roots should be regularly inspected for any signs of mold or spoilage, and if detected, the infected pieces should be removed from the room. Depending on the water content at the time of harvest, roots will lose approximately 75% of their fresh weight during the drying process (Davis and Dressler, 2012). During this time the exterior color of the roots will darken slightly, turning from reddish to brown, but the inside of the root should maintain a vibrant reddish color. To determine when the drying process is complete, select several average-sized roots from the batch, and then break them in half. The roots should snap cleanly when fully dried but should not be overly brittle. After drying, roots should be packaged in appropriate containers (*e.g.* glass, mylar bags, vacuum bags, etc.) and stored in a cool, dark, and preferably climate controlled environment to reduce the likelihood of problems associated with humidity and moisture, which can cause the roots to degrade rapidly.

Black Cohosh

(*Actaea racemosa*)
Ranunculaceae



Overview

Black cohosh is a perennial species that is commonly found growing along forest edges and in deeply shaded forest interiors throughout eastern North America. Black cohosh plants can grow as a single or multiple stem, each with three compound leaves containing multiple serrated leaflets. Plants are typically tall in stature, with flowering stalks emerging in mid-summer and reaching heights of 3' to 8' (Persons and Davis, 2014). Black cohosh rhizomes have long been prized as a valuable medicinal herb and in recent years have become a primary component of commercially available post-menopausal formulations. Between 2000 and 2010, an estimated 2.7 million dried lbs. of black cohosh root were traded on the world market, representing the harvest of approximately 40-54 million plants (Davis and Dressler, 2013). With only 5% of the market demand currently being supplied by cultivated sources (Davis and Dressler, 2013), there is significant need to increase forest-based production of this species.

Site Selection

Black cohosh is typically found growing on north, northeast, and east facing aspects under a mature forest canopy that provides approximately 50%-80% shade. When grown at higher elevations (<3,400 ft.) black cohosh can tolerate as low as 35% shade, which growers report can increase root yields by 18%-20%. Within these baseline conditions, black cohosh prefers sites with well-drained soils that are rich in organic matter, thick leaf litter, and a slightly acidic soil pH (5.5.–6.5) (Davis and Dressler, 2013; Naud et al., 2010). The presence of companion plants and other indicator species can also signify potentially suitable production sites. Species that are commonly found growing in association with black cohosh include, but are not limited to, tulip poplar, sugar maple, basswood, and spicebush (Braly, 2007), Jack-in-the-pulpit, rattlesnake fern, enchanter's night shade, wild geranium, and other associate species (Burkhart, 2013).

Propagation trials have shown that the growth of black cohosh is highly influenced by soil pH, with the largest increases in root mass achieved at pH levels between 6 and 7 (Naud et al., 2010). This suggests that calcium-based soil amendments and/or liming may be beneficial to black cohosh plantings (Naud et al., 2010). For sites that are less than ideal, such as those with poorer quality soils, inadequate shade, or the lack of companion/indicator plants, modifications can be made to increase your chance for success. Modifications may include developing cultivated planting beds, amending soils to optimize growth, and/or erecting artificial shade structures to provide the proper amount of shade (Davis and Dressler, 2013).

Site Preparation

To prepare the growing site for a wild-simulated planting, start by removing any fallen branches, rocks, or other debris that will interfere with the planting process. If necessary, selectively remove small trees and shrubs, or prune low hanging branches to improve airflow and optimize light conditions. If invasive species are present, they should be manually removed and/or controlled prior to planting.

For woods-cultivated plantings, mark the boundaries of your planting beds to prevent damage to surrounding vegetation during the site preparation process. Beds can be made to any size and dimension but should be narrow enough to allow for easy maintenance and management (approx. 4’- 5’ wide). Once the beds have been marked, remove, thin, or prune competitive and suppressive vegetation within the planting area. After the vegetation has been removed, apply any necessary soil amendments, and then shallowly till the beds with a heavy-duty tiller or tractor to loosen the top 3”- 6” of soil.

Propagation trials have shown that black cohosh plants grown under higher light conditions (*e.g.* 78% shade vs. 90% shade) produce more biomass (*e.g.* seeds, roots, leaves), and have higher alkaloid concentrations (McCoy et al., 2007; Naud et al., 2010). Regardless of which production method is used, increasing the amount of available light in the growing site may be advantageous.

Propagation from Rhizome Cuttings

Black cohosh is most commonly propagated by subdividing mature rhizomes into smaller rootlets that can be replanted. As illustrated in figure 8, rhizomes should be divided into 1.5” to 3” long segments, each with several fibrous roots and a dormant bud whenever possible (Davis and Dressler, 2013).

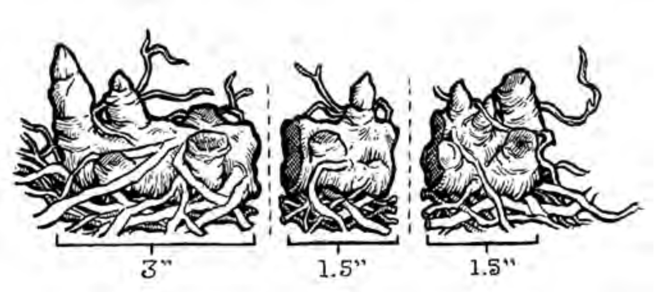


Figure 8.

Fibrous roots facilitate the uptake of water and nutrients, making them critical to the survival of young transplants. Rootlets with healthy fibrous roots present at the time of planting had a 60% higher rate of survival than those without adequate fibrous root material (Small et al., 2011). Differences have also been observed in the growth of transplants based on which part of the rhizome the rootlet originated. After 3 years growth, transplanted rootlets that included the actively growing tip of the root and terminal bud were found to produce higher yields than segments originating from the rhizome midsection (McCoy et al., 2007). Although, when 2-4 buds were present on midsection segments, transplants were shown to produce yields comparable to those reported for terminal segments (McCoy et al., 2007).

If rhizomes and/or rootlets are stored prior to or after subdividing, care should be taken to prevent excess moisture from accumulating in the storage container in order to prevent the growth of fungal pathogens (Thomas et al., 2006; Small et al., 2011). To prevent moisture accumulation roots can be mixed with peat moss and stored in mesh/burlap bags or cardboard boxes that will allow adequate ventilation (Davis and Dressler, 2013).

Propagation from Seed

Black cohosh can also be propagated from seed, but germination can be inconsistent and/or difficult to achieve (Kaur et al., 2013). As with many woodland herbs, black cohosh seeds have an underdeveloped embryo when they ripen on the plant and require a period of warm/cold stratification to break seed dormancy and enable germination to proceed (Persons and Davis, 2014; Kaur et al., 2013). Black cohosh seeds have a relatively weak physiological dormancy, with most seeds being capable of germinating after 8 weeks of cold stratification (Albrecht and McCarthy, 2011). The easiest way to ensure successful stratification is to collect the seeds as they ripen on the plant during the late summer and fall months and sow them immediately after collection. Seeds are ripe and ready to collect when the seed pods turn from green to dark brown, and the seeds rattle inside the capsule when shaken. By sowing immediately, the seeds will be exposed to the natural temperature fluctuations of the seasons and will complete their stratification process without the need for any further interventions (Davis and Dressler, 2013).

Planting Rhizomes and Seeds

Rhizomes:

Rhizomes and/or rootlets are typically planted in the fall of the year but can also be planted in early spring while the roots are still dormant. Plant roots approximately 18”-24” inches apart in prepared woodland production beds, planting furrows, or individual holes. The roots should be planted deep enough so that the bud is covered by 1”-2” of topsoil and an additional 1”-2” of leaf litter (Greenfield and Davis, 2004, McCoy et al., 2007).

Seeds:

Plant seeds approximately 1.5” deep and 1.5”-2” apart in a prepared woodland nursery bed or wild-simulated planting site and then cover with 1” of hardwood leaf litter (Davis and Dressler, 2013). Seeds that are planted immediately after collection should germinate at a relatively high rate (Albrecht and McCarthy, 2011), but some seeds may not germinate until the following spring (Davis and Dressler, 2013).

Maintenance

Once established, plantings will require periodic maintenance, such as inspecting for signs of herbivory, disease, and mortality as well as pruning or weeding to maintain optimal growing conditions. Because the emerging stalks of black cohosh are strong, they can push through a relatively thick layer of leaf mulch. Periodically applying an additional 4”-6” layer of composted hardwood leaf mulch will help to improve the soil quality and provide for optimal plant growth.

Pests and Disease

Black cohosh is susceptible to infection by several fungal pathogens, including leaf spots, root rots, and damping-off disease (Davis and Dressler, 2013). Diseases are most common in sites with inadequate airflow and poorly drained soils (Thomas et al., 2006), making site selection and preparation an important step in disease prevention. Depending on your location, white-tail deer may also be considered a common “pest” that can cause significant crop damage, particularly by browsing the foliage, which causes reduced root growth and seed production. Growers may also encounter problems with slugs and various species of insects (Davis and Dressler, 2013). As we have previously noted, always use organic insecticides, fungicides, and other deterrents as the first line of defense if serious disease or pest problems arise (Davis and Dressler, 2013).

Harvesting

Using a spade fork or other digging tool, carefully harvest transplanted rhizomes after 4-6 years of growth, taking care to keep all parts of the root intact. Rhizomes should be harvested in the fall when root mass and medicinal potency are at peak levels (Davis and Dressler, 2013).

Washing

After harvesting, roots should be washed thoroughly to remove all dirt, debris, and foreign root material. Sometimes breaking the root may be necessary to fully dislodge all unwanted materials. Briefly soak roots in a bucket of water to soften the dried dirt and debris clinging to the root, and then spread the roots on a wire mesh screen and spray with a medium pressure hose. A small soft-bristle brush can also be used to remove dirt from hard to reach areas. Mechanized or hand powered root washers can also be used and may be a better alternative for washing large volumes of root material (Davis and Dressler, 2013).

If roots are to be kept fresh, they can be mixed with moist sphagnum moss and stored in mesh/burlap bags or cardboard boxes under refrigeration (40°F). Stored roots should be aerated frequently and inspected for signs of drying, mold, and spoilage (Davis and Dressler, 2013).

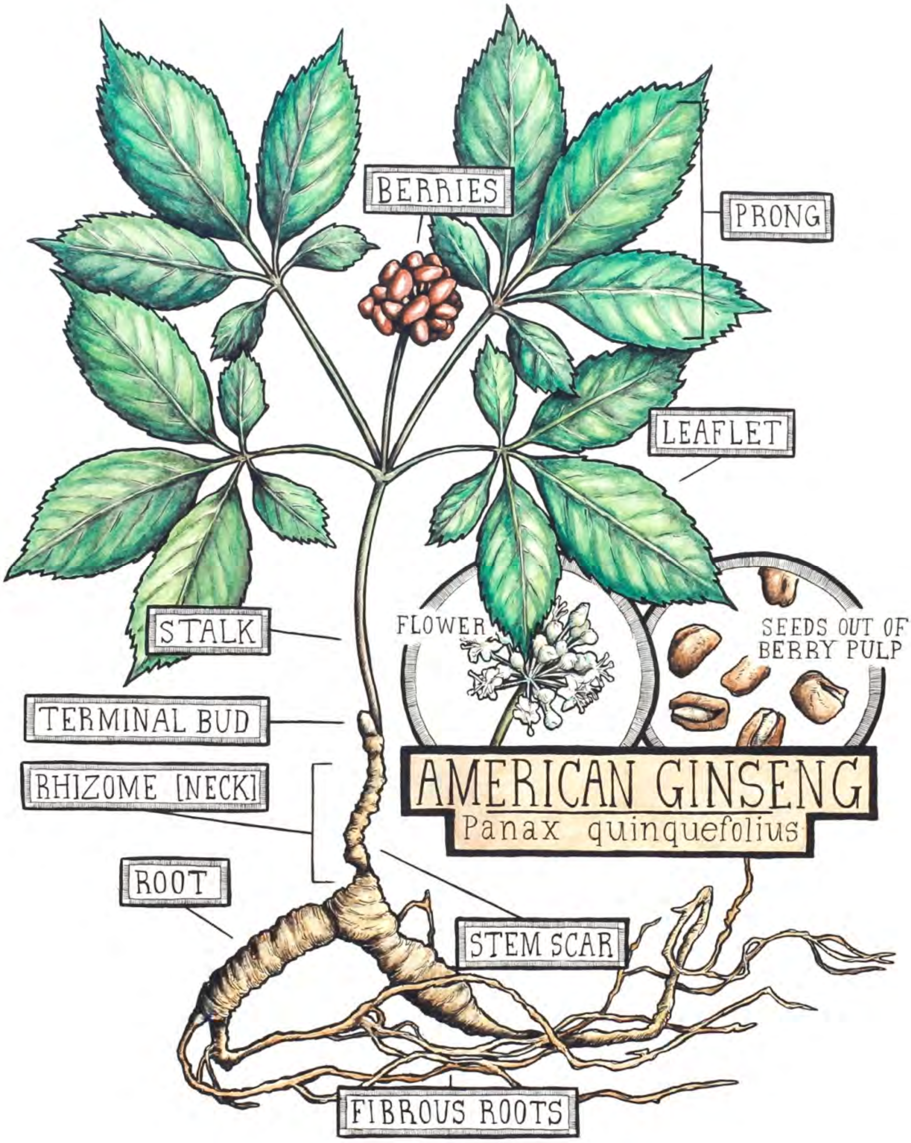
Drying

Roots must be properly dried in order to preserve product quality and ensure the integrity of the product during long-term storage. To dry, spread roots evenly on a wire mesh screen in a dark, well-ventilated area with adequate airflow, and where temperatures can be maintained at 85 -95°F for 7-10 days, or until completely dried (Davis and Persons, 2014). In humid locations, temperatures as high as 130°F may be needed to fully drive off excess moisture from the roots (Davis, 2016). The roots should be regularly inspected for any signs of mold or spoilage, and if detected, the infected pieces should be removed from the room. To determine when the drying process is complete, select several average-sized roots from the batch, and then break them in half. The roots should snap cleanly when fully dried but should not be overly brittle.

After drying, roots can be further cleaned by agitation. Because the roots shrink during the drying process, excess soil and debris that remained on the root after the initial washing become loosened and can be knocked free from the root when agitated. Since agitation can also separate many of the fibrous roots, it may be necessary to screen the debris to reclaim as much of the botanical material as possible. The size of the sifting screen used will depend on the particle size of the materials being sifted.

American Ginseng

(*Panax quinquefolius*)
Araliaceae



Overview

American ginseng (*Panax quinquefolius*) is a long-lived perennial herb that is native to the deciduous forests of eastern North America. Due to its high value, which can range from $600 to more than $1,000 per dried pound, American ginseng has been over-harvested throughout much of its natural range. Intense harvest pressure on wild populations has been further compounded by low reproductive rates, limited seed dispersal, and high seedling mortality. Ginseng roots vary in size and shape and are considered the most valuable part of the plant, although medicinally active “ginsenosides” are present in the leaves, stem, flowers, flower buds, and seed pulp (Qi et al., 2011). American ginseng is highly valued in Asian markets due to a close resemblance to Asian ginseng (*Panax ginseng*), which has been used in traditional Chinese medicine for over 2,000 years (Bergner, 1996). In response to demand from Asian markets, ginseng became one of the early commodities exported from eastern North America and the United States (ca. 1717-1784). Due to concerns about the impacts of harvesting on wild populations, the commercial harvest, sale, and export of ginseng roots has been regulated since 1975 after the species was listed in Appendix II of the Convention on the International Trade of Endangered Species of Wild Flora and Fauna (C.I.T.E.S) (Burkhart et al., 2012). Under CITES, the harvest, sale, and export of wild ginseng is regulated and monitored at both the State and Federal level to ensure that the commercial trade in ginseng roots is not detrimental to the survival of the species (Robbins, 1998).

Life Cycle

Ginseng is a slow-growing species, advancing through a single stage of development each year by adding one new set of compound leaves (Mooney and McGraw, 2009), which is commonly referred to as a “prong” among the ginseng community. After germinating, plants typically persist as seedlings for one to two years and then begin to progress through one-leaf, two-leaf, three-leaf, and four-leaf stages of development over time (McGraw et al., 2013), as illustrated in Figure

9. Progression through these developmental stages is variable, with plants being capable of persisting in juvenile and seedling stages for several years or reverting to lower stages of development in response to environmental factors (*e.g.* drought, herbivory, etc.) (McGraw et al., 2013). Ginseng has a long pre-reproductive period and does not typically reproduce until after 5-6 years of growth, and the three-leaf stage of development has been reached (Mooney and McGraw, 2009), although some seeds may be produced by two-leaf plants (Obae and West, 2011). Ginseng seeds have a functionally underdeveloped embryo when they ripen on the plant and require 18 months of stratification before they will germinate.

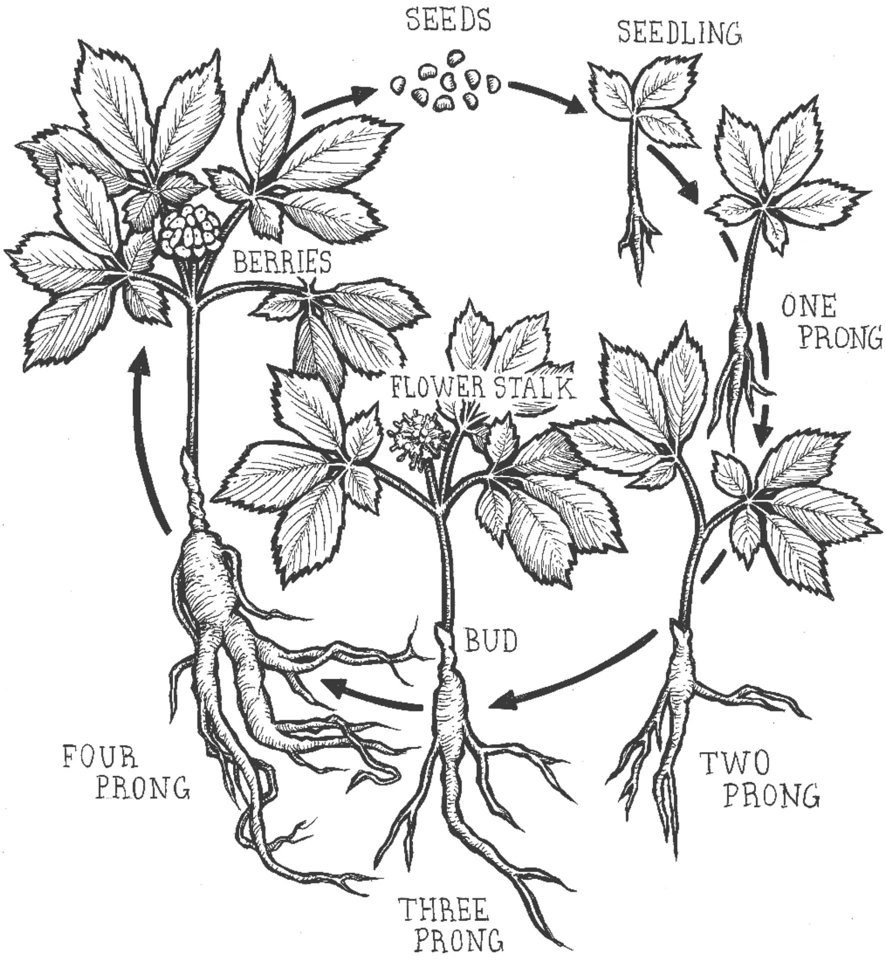

SEEDS
SEEDLING
BERRIES
ONE PRONG
FLOWER STALK
BUD
FOUR PRONG
TWO PRONG
THREE PRONG

Figure 9.

Pollination and Seed Development

Ginseng flowers typically bloom from late June through mid-July and are pollinated by syrphid flies and halictid "sweat" bees, which are generalist pollinators that visit many species of forest plants (Burkhart and Jacobson, 2004). Ginseng plants are also capable of self-pollination, which is a common occurrence when populations are widely dispersed and reproductively isolated. When it occurs, cross pollination contributes to gene flow and genetic diversity among populations and has been found to result in the production of larger plants (McGraw et al., 2013). After pollination, the seeds will develop through the summer months and ripen from late August through September. The "berries" are covered with a fleshy pulp that turns from green to red when ripe. Each "berry" contains 1-2 seeds, which simply fall from the plant if they are not eaten by deer, chipmunks, squirrels, birds, or other frugivorous critters. Recent research has discovered that the wood thrush (*Hylocichla mustelina*), a neotropical migratory songbird that breeds in the hardwood forests of the eastern United States, is one of the few long-distance dispersers of American ginseng seeds and have been observed to move seeds 20-30 meters from the parent plant before depositing them in their new location. (Hruska et al., 2014, Elza et al., 2016).

Ginseng Propagation

Propagation from Seed:

To improve the chances for successful germination, seeds should be collected after the pulp has turned completely red. Seeds that are collected while the pulp is still green tend to have lower rates of germination or may fail to germinate at all (McGraw et al., 2005). The seeds should be collected as soon as possible after ripening in order to prevent potential losses to animal predation. After collecting, the seeds can be planted directly, or they can be cleaned and stored in a stratification box for up to 1 year. ***For direct planting*** of freshly collected seeds, crush the berry pulp between your fingers to retrieve the seeds, and then plant them individually in holes ½" – ¾" deep. The seeds will stratify naturally and should germinate two years after planting.

Seed Stratification:

Stratifying your own seeds can be a tricky process, but it may be worthwhile if you are able to collect a relatively large quantity of seeds from your plantings. As previously discussed, stratification is simply a process where seed dormancy is broken in order to facilitate germination. This is typically accomplished by placing ginseng seeds between layers of coarse-grained sand, and then burying them underground in a stratification box for up to 1 year. The stratification box should be constructed in a way that excludes pests and rodents but still allows water to percolate through the layers of sand and seeds. This is generally accomplished by constructing a box with solid sides and sturdy wire mesh screens on the top and bottom. The porous sand mixture will help keep the seeds moist, while preventing water from accumulating in the box and causing them to rot.

Before the seeds can be stratified, they need to be removed from the pulp. To de-pulp, place the berries in a bucket of water for approximately 12-24 hours to help loosen the pulp from the seeds. Discard the water, and then rinse repeatedly with a medium pressure hose to dislodge the remaining pulp. Before placing the seeds in the stratification box, spread them on a fine mesh screen or drying rack and allow them to air dry to remove excess moisture.

Stratification boxes should be buried to a depth where the top of the box is 8” beneath the surface of the soil (Davis and Persons, 2014). Boxes should always be placed in well drained soils to ensure proper drainage and that water does not accumulate in the hole. Boxes may also need to be periodically pulled up during the stratification process to monitor moisture levels and to check for potential spoilage.

Figure 10.

Propagation from Root Cuttings:

In some cases, “neck division” or “neck replanting” may be a viable way to propagate ginseng roots but will ultimately depend on how the roots will be processed and sold.

Roots that are destined for export markets, or that are intended to be sold as whole and in-tact roots, are not good candidates for neck propagation. But lower-grade roots that are more likely to be processed into root powders and extracts can be very good candidates for neck propagation. As illustrated in figure 10, an ideal cutting will include the root neck, the terminal bud, and one or two small fibrous roots. Simply sever the neck cutting from the main tuber using a sharp clean utensil. Plant the cutting on its side at a 30° angle and 1½”- 2” deep. Based on experimental evidence, approximately half of the cuttings should be expected to emerge the following season (Beyfuss, 2017b).

Site Selection

Ginseng is typically found growing on north, northeast, and east facing aspects under a mature forest canopy that provides approximately 75%-90% shade (Davis and Persons, 2014). Within these baseline conditions, ginseng prefers sites with well-drained soils that are rich in organic matter yet maintain a slightly acidic soil pH (5.5–6.0) (Davis and Persons, 2014). Good soil drainage is essential for healthy ginseng plantings. Ginseng is susceptible to several species of water-borne pathogens, and the accumulation of excess water in the growing site can contribute to the spread of diseases that can decimate ginseng plantings. As we have previously discussed, planting sites with gentle to moderately sloped terrain will help facilitate soil drainage and can go a long way to helping keep your ginseng plantings healthy.

The presence of certain companion plants and other indicator species can also be used to identify and evaluate potential production sites. Species that are commonly found growing in association with ginseng, include, but are not limited to, tulip poplar, sugar maple, basswood, black walnut, red oak, slippery elm, white ash, spicebush, trillium, black cohosh, blue cohosh, goldenseal, Jack-in-the-pulpit, maidenhair fern, rattlesnake fern, and bloodroot (Apsley and Carroll, 2013; Burkhart, 2013).

Soil calcium content has been shown to be highly beneficial to the growth and development of ginseng plantings, contributing to increased root growth and disease resistance (Hankins, 2000).

Evidence suggests that ginseng plantings thrive in soils with calcium levels ranging from 2500–5000 lbs/acre (Beyfuss, unpublished). Many of the species listed above, such as, tulip poplar, sugar maple, Jack-in-the-pulpit, rattlesnake fern, and maidenhair fern (Burkhart, 2013), are all calcium loving species and can help you identify calcium-rich production sites. Phosphorus, which is used by plants to absorb and process calcium, is another important factor to consider during the site selection process. Phosphorus levels of 90 lbs/acre are recommended and can be augmented by supplementing with rock phosphate (Hankins, 2000).

Wild-Simulated Site Preparation

To prepare the growing site for a wild-simulated planting, start by removing any fallen branches, rocks, or other debris that will interfere with the planting process. These can be staged adjacent to the planting site and can be thrown back on after seeding to help hold the leaf litter in place. If necessary, selectively remove small trees and shrubs, or prune low hanging branches to improve airflow and optimize light conditions. If invasive species are present, they should be manually removed and/or controlled prior to planting. Native understory plants should be left in place to help maintain a diverse polyculture of plants, which will also help to limit the spread of pathogens (Hankins, 2000).

Planting Seeds Using the Wild-Simulated Method

Whether collected and stratified yourself, or purchased from a commercial supplier, ginseng seeds should be planted in the fall of the year as temperatures begin to cool, and when there is adequate moisture to ensure that seeds will not dry out after planting. Seeds can be planted anytime during the fall months, but it is best to plant just before peak leaf drop, which helps to ensure that the seeds will be well insulated by the layers of freshly fallen leaves.

Working across the slope, rake the leaf litter downhill to create wild-simulated “beds” that are approximately 4’-5’ wide and up to 50’ long.

After the leaves have been cleared, scuff the surface of the soil with a hard steel rake to loosen the top ¼" of material. From the uphill side of the bed, broadcast seeds at a rate of 5-7 seeds/sq. ft. and even disperse across the bed (Apsley and Carroll, 2013, Davis and Persons, 2014). After seeding, move uphill and prepare to make a second bed. Rake the leaves from the second bed downhill to cover the previously seeded area, covering the bed with approximately 1-2 inches of leaf litter. Simply repeat the process until the site has been fully planted.

Planting Rootlets

Ginseng plantings can be started by transplanting young rootlets but require more financial investment when compared to seeds, and the survival of transplants can be highly variable. Transplanted roots and/or rootlets should be planted approximately 2"- 2½" deep with the terminal bud approximately 1" - 1½" beneath the surface of the soil. Rootlets should be planted on their side at a slight angle (approx. 30° angle) with the fibrous roots spread laterally. After planting, backfill with the removed soil and re-covered with approximately 2" of leaf litter (Bennett et al., 2011).

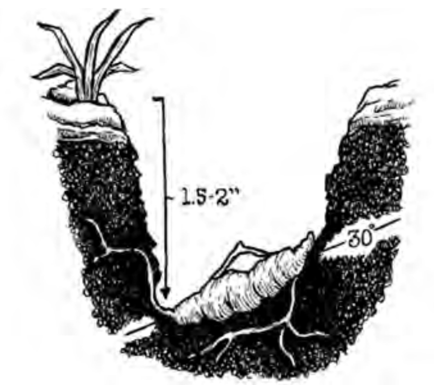


Figure 11.

Maintenance

Plantings should be regularly inspected for signs of disease and evidence of other disturbances, such as predation by common pests, or signs of unwanted trespassing and/or poaching. As previously noted, the amount of crop maintenance will depend on the intensity of site preparation and the extent of site modifications. For wild-simulated and woods-cultivated plantings, periodic thinning/pruning of competitive vegetation may be needed to maintain an open growing site, as well as light weeding. If plants fail to thrive in a particular growing site, the addition of beneficial nutrients may be required, such as pelletized gypsum to boost calcium concentrations (Hankins, 2000), and composted leaf mulch to increase organic matter.

Pests

Deer:

Whitetail deer have been identified as one of the main threats to the long-term viability of wild ginseng populations (FWS, 2016; Furedi and McGraw, 2004), and this threat holds true for forest-farmed plantings as well. Repeated browsing can cause decreases in root mass, loss of seed production, as well as contributing to prolonged periods dormancy or even death. Addressing deer problems can be a difficult and potentially costly intervention. Electric and non-electric fences, natural barriers, and other protective structures will all help to reduce the frequency of deer browsing and will have varying degrees of efficacy. Active hunting and agricultural nuisance permits can also be an effective means of controlling deer populations on and around your property.

Mice, Moles, and Voles:

Mice, moles, and voles are rarely seen but can cause significant damage to ginseng crops by consuming roots, de-hulling and destroying seeds, and severing the base of the stem from the root. Commercially available baits and traps can be an effective way to reduce the number of these critters in your production site, but significant care should be taken to protect baits/poisons from the elements in order to prevent contamination of the site, and consumption by non-target wildlife.

Slugs:

Slugs primarily feed on ginseng leaves and can cause significant mortality among first-year seedlings. Organic controls such as homemade beer traps and surrounding plants with diatomaceous earth are both effective means of control (Scott et al., 1995).

Commercial slug repellents are also available, but care should be taken when applying these products in order to prevent contamination of plants or the growing site.

Diseases

Ginseng is susceptible to a variety of fungal pathogens that can potentially destroy an entire planting if left unchecked. The first line of defense in disease control is prevention. By selecting good growing sites and maintaining healthy growing conditions, such as ensuring that there is adequate airflow and maintaining planting densities of 1-2 plants per sq. ft., the potential for disease outbreaks can be significantly reduced. Planting or maintaining a diverse polyculture of species can also help prevent the spread of pathogens (Apsley and Carroll, 2013). Learning the signs and symptoms of common ginseng diseases is strongly recommended.

Alternaria Blight:

Alternaria leaf blight, caused by *Alternaria panax*, is one of the most common fungal diseases found in ginseng plantings. Infected leaves will display patchy, yellow/tan, bullseye-shaped lesions that will ultimately defoliate the plant. Leaf blight is not typically fatal in mature plants but will stunt growth (Beyfuss, 2017). If Alternaria is present, care should be taken not to spread the spores between sites. The fungal spores overwinter on infected leaf material and will continue to re-infect plants the following season. Therefore, the leaves from infected plants should be collected and removed from the site whenever possible to prevent reinfection (Vaughan et al., 2009).

Damping Off:

Damping off disease typically infects seedlings in the spring when conditions are cool and moist. The species of fungi that cause damping off disease live near the soil surface and attack seedling stems as they germinate and emerge (Apsley and Carroll, 2013). Seedlings that tip over and rot soon after germinating are common signs of damping off disease. Close examination of seedlings will show a tapering/constriction at the base of the stem where it has rotted away from the root (Beyfuss, 2017). Mature plants can typically resist damping off, but seedlings will likely die once they have been infected.

Phytophora Root Rot:

Root rot disease occurs less frequently than other pathogens (*e.g. Alternaria*) but is considered one of the most serious and deadly ginseng diseases. Root rot tends to infect mature plants in the 3-4 years old age classes and can arise very rapidly. The leaves of infected plants will appear to spontaneously wilt and discolor (turning yellowish/red) in a very short period of time, signaling the ultimate demise of the plant. Infected plant material, and potentially the soil from immediately around the root, should be removed to prevent the spread of the disease. If the roots have completely disintegrated by the time the disease is noticed, the hole that the plants were growing in should be sterilized with a bleach and water solution (1 cup bleach/per gallon water). Similarly, any tools used to remove infected plants or soil should be sterilized to prevent reinfection (Beyfuss, 2017). The good news is that many of the disease problems listed above can be virtually eliminated in a wild-simulated setting by taking the time to select optimal growing sites and following the wild-simulated planting guidelines provided in this handbook.

Harvest Regulations

By law, “wild” ginseng roots cannot be legally harvested before September 1st or before they have reached 5 years of age. Most states that have active ginseng management programs do not make any distinction between wild and wild-simulated roots, leaving wild-simulated growers subject to the laws that have been developed to regulate “wild” ginseng. Fortunately, this is not a significant obstacle for wild-simulated producers to overcome, since wild-simulated roots are not typically harvested until after 7-10 years of growth and are harvested in the fall of the year. It is important to familiarize yourself with any relevant State and Federal regulations governing the harvest and sale of ginseng roots to ensure regulatory compliance. You should also contact your State Regulatory Agency to address any questions that you might have.

Harvesting Roots

Ginseng roots should be harvested in the fall of the year after all seeds have fully matured, and the leaves have begun to turn yellow and die back. At this stage of development, root ginsenoside concentrations reach peak levels as medicinal constituents in the leaves are reabsorbed by the root system (Li, et al., 1996), thus helping to ensure a high-quality product. Ginseng roots are largely valued based on their appearance, and great care should be taken during the harvest process to preserve the physical qualities of the root. Roots can be harvested with a variety of tools, including spade forks, soil knives, and small or large mattocks. Regardless of the tool, it is important to select the implement that you are most comfortable with, and that can be used effectively without damaging roots. Digging should begin slowly and at least 6-10 inches from the stem to avoid breaking the fibrous roots that extend into the soil surrounding the plant (Vaughan et al., 2009).

Washing

Washing ginseng roots can seem somewhat counterintuitive because, unlike other species, having a small amount of residual dirt on the root is actually desirable, specifically between the dense growth rings on the root body. Roots should not be scrubbed clean with a brush, as they will have an unnatural whitish appearance and will typically result in a lower market value (Davis and Persons, 2014). The best way to prevent over-washing is to briefly soak roots in a bucket of water, and then rub them with your fingers to remove excess dirt and debris. When the roots are rubbed clean, a small amount of dirt is left between the dense growth rings on the exterior root and helps accentuate the roots' wild characteristics.

Drying

Roots must be properly dried in order to preserve product quality and ensure the integrity of the product during long-term storage. To dry, spread roots evenly on a wire mesh screen in a dark, well-ventilated area with adequate airflow where temperatures can be maintained at 85-95°F. In humid locations, temperatures above 100°F may be needed to fully drive off excess moisture from the roots (Davis, 2016). The roots should be regularly inspected for any signs of mold or spoilage, and, if detected, the infected pieces should be removed from the room. During the drying process, roots will lose approximately 70% - 75% of their weight, and the color will darken slightly, turning from white/cream to light brown. While the exterior of the root may darken slightly, the inside of the root should maintain a whitish color. Roots that are dried too quickly can develop a dark "sugar" ring on the inside of the root, which can lower the root value (Vaughan et al., 2009). To determine when the drying process is complete, select several average-sized roots from the batch, and then break them in half. The roots should snap cleanly when fully dried but should not be overly brittle.

Ginseng roots can also be kept fresh for several weeks by storing them in the refrigerator. Fresh roots should be stored in a plastic bag with a moist paper towel that can either wick up excess moisture or release moisture to the roots when needed. Bags should be opened regularly to exchange fresh air and to inspect the roots for signs of spoilage.

Harvesting and Drying Ginseng Leaves

Ginseng leaves also contain relevant concentrations of ginsenosides and may be a product that can help producers generate income while waiting for roots to reach a harvestable size/age. Leaves should only be

Figure 12.

collected from mature 3-prong and 4-prong plants, and it is recommended that at least 2 prongs be left on each plant in order to minimize any negative effect on root growth. Leaves should be collected between July and August when ginsenoside concentrations are at peak levels (Li et al., 1996, Li and Wardle, 2002).

Ginseng leaves can be dried using the same technique previously described for roots but can be successfully dried at lower temperatures. Small quantities of leaves can be dried in a forced air dehydrator, but larger quantities will need to be laid out on drying screens and/or racks. Leaves should be fully dry within a few days and should maintain their vibrant green color. Leaves that are dried too slowly tend to discolor and turn a pale yellowish-green.

Chapter 4

GAP’s and BMP’s

Good Agricultural Practices (GAP’s) for Forest Farmers

Good Agricultural Practices (GAP’s) are a collection of guidelines that forest farmers can use to help them maintain the basic environmental and operational conditions necessary to ensure that products they are entering into commerce are true to origin and identity and free from potential botanical, microbial, and chemical contaminants. This section will provide a brief introduction and overview of suggested GAP’s that will help forest farmers adopt and adhere to industry-recognized best management practices, meet buyer specifications, and successfully conduct business in the herbal products industry.

Meeting Buyer Specifications

If materials are destined for a particular buyer, be sure that all specifications specific to that buyer have been met (*e.g.* packaging, labeling, processing, etc.). Each buyer will have varying criteria for how they grade and assign value to the materials they purchase, and it is essential to understand these criteria early in the production process, such as what GAPs need to be followed, minimum acceptable alkaloid contents, and how roots should be cleaned, dried, and packaged (Davis and Persons, 2014). To help ensure that specifications are met, simply request a copy of the specification sheets for the products you intend to sell. These sheets will not only outline the specifications like those listed above, but will also inform you about what testing your products will be subjected to and the test parameters used to evaluate the materials. In some cases, growers who are interested in producing raw materials for the large-scale resale market will have to undergo a vendor approval process to confirm that they meet the requirements of the Food Safety Modernization Act (FSMA).

Plant Identification

Growers should have the knowledge and ability to positively identify all plant materials to ensure that they are true to the species that is intended for harvest and sale.

Proper identification is critical at both ends of your supply chain, from the planting stock you purchase to plant, to the material that you have harvested to sell or process. As the grower, you are ultimately responsible for the identity of what is put in the ground and entered into commerce. For those who are new to forest farming, attending plant walks and workshops as well as spending time in the woods with experienced herbalists and forest farmers can be a good way to develop your identification skills and familiarize yourself with the characteristics of the species you are interested in growing. Secondly, all seeds and root stock should be purchased from reputable and knowledgeable suppliers to help ensure that the materials you receive have been positively identified, labeled, and legally acquired.

Retain a full voucher sample of harvested materials, including the root, stem, leaves, flowers, and seeds.

A voucher sample is simply a dried whole-plant specimen that can be used to verify the identity of plant material that was harvested at a particular time and place. Samples should be maintained for each species and production site to ensure that products can be traced to the point of origin. Retaining voucher samples requires additional investments on behalf of the grower to collect, prepare, and store samples but adds a level of accountability that many herb buyers require.

Harvest and Post-Harvest Handling

Do not harvest material that is growing within or near a contaminated location.

As a grower it is important to keep in mind that the products you are producing are intended to be used as medicine and should be as pure and free from contamination as possible. Unfortunately, some potential sources of contamination may have occurred in the distant past and may require further investigation, such as prior applications of agrochemicals (*e.g.* DDT, glyphosate, etc.), chemical spills (*e.g.* gasoline/diesel fuel, motor oil, etc.), and homestead landfills. Other potential sources of contamination to keep an eye out for include roadside run-off, herbicide/pesticide/fertilizer residues and run-off, creosote from utility poles, un-composted (raw) manure, and similar substances. Assessing the potential for site contamination prior to planting is essential, as contaminated products will not be marketable.

Harvest at the appropriate life-stage of the plant to ensure medicinal quality and conservation benefits.

Each species should be harvested at the appropriate time of year to help ensure that products have consistently high levels of medicinally active constituents. The timing of harvest activities may vary by species and by the part of the plant being harvested (*e.g*. roots vs. leaves). As previously discussed, root crops should be harvested in the fall, as constituents from the leaves and stems are concentrated in the root for winter storage. Similarly, peak leaf concentrations tend to be correlated with seed ripening and should be harvested during the late summer months after the seeds have been collected or dispersed.

Harvesting plants at the appropriate stage of development is an important conservation consideration. Plants should not be harvested until all seeds have fully ripened and have been collected or naturally dispersed. The seeds should be used in a way that helps to enhance and expand the parent population or to create new populations.

Maintain cleanliness during harvest and post-harvest handling activities.

Prior to harvesting make sure that all of the tools and equipment that you will use during the process are clean and free from foreign debris and other potential contaminants. After harvesting, the plant material should be protected from the elements (*e.g.* sun, rain, freezing, and excessive heat) and handled in a way that protects the products from potential sources of contamination, such as animals and their waste, smoke, natural and artificial fragrances, and similar substances.

Washing and Drying

Wash roots thoroughly and ensure that all buyer/market specifications are met.

Roots and other plant materials should be appropriately washed/cleaned to ensure that they are free from any unwanted dirt and debris (*e.g.* weeds, other plant parts, rocks), and that they will meet the requirements of your buyer/market. Washing should be conducted in a clean area and on clean surfaces to reduce the potential for contamination. Wash tubs and sorting surfaces where plant materials are processed should be constructed of non-reactive food-grade materials (*e.g.* stainless steel, plastic) that are resistant to marring, and can be efficiently cleaned and sterilized. In addition to maintaining clean equipment, the water that is used to wash plant materials should also be from a sanitary source. If possible, only potable water from a municipal, or tested and certified natural source (*e.g.* spring, well, cistern) should be used during the washing process but should always be used for the final rinse.

Ensure that all plant materials are properly dried to preserve the integrity of the product.

All plant materials should be dried to the proper final moisture content (avg. 8%-12%) that will meet the needs of your buyer and ensure the integrity of the product during long-term storage. Depending on the ambient temperatures and humidity in your local area, a mechanical dryer with an electric heat source may be needed to produce a quality product. If possible, dryers should be dedicated to food and herbal products only and constructed of non-porous materials that can be cleaned and sanitized. Drying racks and screens should also be made of non-reactive and preferably food-grade materials that can be efficiently cleaned and sanitized.

Packaging and Storage

All plant materials should be packaged in appropriate food-grade materials and stored in a way that prevents the product from degrading.

It is important that plant materials are packaged, labeled, and stored in the way that has been specified by, or will be acceptable to your intended buyer. Food-grade packaging, such as poly-sacks, cardboard drums and boxes, glass jars, Mylar bags, plastic-lined paper bags, and plastic bags, are all considered acceptable for storing botanical materials. After packaging, materials should be stored in a cool, dry, and well-ventilated environment where they are protected from the elements (heat, sun, freezing, humidity, etc.), and potential sources of contamination, such as rodents, insects, smoke, and fragrances. Based on your location, an air-conditioned room may be required to reduce humidity and ensure proper long-term storage.

Record Keeping

Detailed records should be maintained to ensure that all products are traceable to their origin.

Detailed records documenting where, when, and how each crop was grown and harvested should be maintained to ensure that all products are traceable to their origin. To improve traceability, every batch of plant material that you process should be assigned a lot number, and a voucher sample for each lot number should be maintained. Lot numbers should be recorded on each package, along with the proper common and scientific name. Records should include a complete listing of any amendments or additives that were applied to the plants or growing site and should also account for how the material was washed, dried, and processed.

Recommended Best Management Practices

Maintain growing conditions that help reduce the potential for pests and disease.

As the saying goes, an ounce of prevention is worth a pound of cure. By utilizing forest farming techniques that contribute to healthy and diverse forest ecosystems, and by selecting growing sites that meet the needs of the species being cultivated, the need for disease interventions can be significantly reduced.

Maintain organic cultivation practices whenever possible, even if you are not planning to be "certified organic."

Whenever possible, use only natural and/or organic products that are appropriate for the species and intended application. For a list of approved inputs, consult the National Organic Program Standards and the Organic Materials Review Institute (OMRI).

Establish a supply chain that relies on intentionally cultivated seed and planting stock.

Purchasing planting stock from reputable cultivated sources will help to reduce/eliminate the potential for misidentification and help to ensure that all purchased raw materials are true to origin and identity. Furthermore, purchasing cultivated and forest farmed materials help to support small farms and forest farmers.

When harvesting, subdivide and replant part of the root whenever possible to help ensure regeneration.

Ensuring successful regeneration and reproduction provides not only conservation benefits but can also help reduce the need to purchase additional planting stock and improve your bottom line.

Sources: (Davis, Jeanine.,2016; American Herbal Products Association, 2017; Davis and Persons, 2014; Carpenter & Carpenter, 2015).

Chapter 5

Reflection on Forest Farmers of the 19th Century

"I again plead for government and state intervention in such direction as this. If it is proper to preserve a lingering group of bison, or to search the land over for our vanished wild pigeon, why is not proper to conserve, with the help of the strong hand of authority, AMERICA'S valued flora from absolute extermination?"

– *John Uri Lloyd* ("The Cultivation of Hydrastis," 1912)

What is old is new again, and thus United Plant Savers' and Rural Action's "innovation in conservation" to inspire a new generation of forest famers builds on a historical legacy of forest farmers of the not so distant past. This booklet hopefully re-inspires the ethics of the Eclectic tradition and provides a renewed look at the knowledge of forest farmers from the past to inform a new generation that is passionate about forest botanicals.

Eclectic Medicine was a branch of traditional American medicine, which made use of botanical remedies along with other substances and physical therapy practices popular in the latter half of the 19th and first half of the 20th centuries. The ethics in regard to plants being harvested for commercially produced remedies were a concern expressed by the Eclectics under the leadership of the Lloyd Brothers, who were inspired in their passion for native botanicals by the plant explorers of the new world. Botany and herbalism were historically intertwined disciplines, as noted in classical texts such as C.S. Rafinesque's *Medicinal Flora or Manual of Medical Botany of the United States* published in 1830. These early botanists, who explored the "New World" documenting botanical knowledge of the diverse Appalachian forests, befriended Native Americans for their extensive knowledge of the ecosystem they knew intimately, which included the medicinal uses of plants. Traditional ecological knowledge of numerous indigenous communities across the Appalachian region is the cornerstone of our understanding of not just the identification and uses of native medicinal plants, but also includes appropriate times and methods of harvest, and sustainable management practices. The Lloyd brothers and many other early American authors were critical in creating a bridge to our current understanding of these plants.

The Lloyds had the foresight and vision to know that this knowledge would always be relevant and critical even though they would bear witness to the changes taking place in land use, medical practices, and plant based pharmacy. They established the Lloyd Library, an extensive collection dedicated to medicinal plants and the only library to have a series of historical subscription based publications that shared forest farming techniques among land owners and prices of medicinal plants in commercial trade. One such series, published by Penn Kirk in 1914, is the "Ginseng and Goldenseal Bulletin," which started its monthly subscription in 1914 and has recently been digitized and is now available online. By reading this series you find that there was an extensive network of woodland farmers growing medicinal plants. In this particular bulletin forest farmers shared trials and tribulations, along with advertisements and antidotes. The publication ended in 1920, as herbal remedies slowly faded from local stores and medical practices, and thus the growers themselves were forgotten. Herbal remedies are now regulated under the Dietary Supplement Act passed in 1994, and herbal products are now back on the shelves and therefore the demand for forest farmers has re-emerged.

In 1912 John Uri Lloyd published "The Cultivation of Hydrastis" in the *Journal of the American Pharmaceutical Association* at the request of the editor because of expressed concern about loss of habitat and over harvesting. It is always insightful to take a historical perspective when studying horticultural plant knowledge. Lloyd's article sharing insights from forest farmers of the past is republished in its entirety in this booklet.

THE CULTIVATION OF HYDRASTIS

JOHN URI LLOYD, PHAR. M.

REPRINT FROM
THE JOURNAL OF THE AMERICAN PHARMACEUTICAL ASSOCIATION
January, 1912

THE STONEMAN PRESS, COLUMBUS, OHIO

Showing Hydrastis beds of Dr. G. W. Homsher, Camden, Ohio.

THE CULTIVATION OF HYDRASTIS.*

JOHN URI LLOYD, PHAR. M.

NAMES. Hydrastis is known under the name *Golden Seal,* by reason of the yellow, seal-like scars on its fresh rhizome. The name *yellow root* is extensively employed by collectors, while the name *yellow puccoon,* once common, is now practically obsolete. The following names have also been employed to designate Hydrastis, for obvious reasons; *eye balm* and *eye root,* because of its use in eye affections; *Indian paint, yellow paint* and *Indian dye,* because the North American Indians used the root for coloring purposes; *Indian turmeric, wild turmeric, golden root, curcuma, Ohio curcuma,* and *wild curcuma,* because the drug resembles curcuma; *jaundice root,* because of its yellow color; *yellow eye,* because of the yellow scars (eyes) above alluded to; and *ground raspberry,* because of its red berry, resembling a raspberry. The name most used, from the beginning to the present date, is *Golden Seal.*

NATIVE DISTRIBUTION. Originally, Hydrastis was more or less abundant over the wooded portions of Ohio, Indiana, Kentucky and West Virginia, Cincinnati

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* This article is written in the first person, and, by request of the editor, gives facts concerning Hydrastis culture as observed in my own experimentations, corroborated by others known to me personally. No attempt has therefore been made to embody the experiences of persons who have heretofore printed articles on the subject, nor have my own previous publications, or my own photographs and detail notes been used at all, excepting briefly. The cuts, excepting those showing the Hydrastis farm of Dr. Homsher, are from *Drugs and Medicines of North America,* 1884, or from others of my previous prints on the subject. The object being to present the problem so as to save to others experimental wanderings, I must yet urge the reader who proposes to enter the field of Hydrastis culture, to study carefully the Bulletins issued on this subject by the Agricultural Department of the United States Government, especially the admirable pamphlet of Miss Alice Henkel and G. Fred Klugh, of the *Bureau of Plant Industry.*—L.

being nearly the geographical center of its original commercial area. Pockets of it were also found in Southern Illinois, Southern Missouri, Northern Arkansas and Central and Western Tennessee, these sections occasionally yielding the drug in quantity sufficient for collection. It was scarce throughout most of Illinois, Northern Indiana, Southern Michigan, the Southern Peninsula of Ontario, Pennsylvania and Western New York, and was occasionally found near the base and along the ravines of the Allegheny Mountains. Its area of distribution in former years is illustrated by the accompanying map (Fig. 3), reduced from *Drugs and Medicines of North America,* 1884.

Fig. 1.
Hydrastis Fruit.
(One-fourth Size)

The natural location of Hydrastis is in rich, open woods, where leaf mold is abundant. Although easily cultivated (as shown hereafter), it has no power to adapt itself to destructive, altered natural conditions, being quickly exterminated by cultivation of the soil. Even cutting off the trees for woodland pastures, especially in clay soil, causes the wild plant to disappear in a few years. Its greatest enemy is grass sod, which smothers it from existence. The plant will, however, stand extremes of temperature, as is evidenced by its natural distribution. A small but very luxuriant garden bed of Hydrastis was shown me some years ago by a friend in Detroit, while in my own garden in Cincinnati it grew and throve in a glazed-over, grass-free bed, even though exposed to the blazing, direct rays of the sun.

Commercial History. In 1793, the American Philosophical Society published in its Transactions (p. 224), a paper by Mr. Hugh Martin, read before that society under the title, *"An Account of Some of the Principal Dyes Employed by the North American Indians."* In this we find the first reference to Hydrastis, Mr. Martin stating that the bright yellow dye of the Indians was obtained by the use of a plant that he said might well be called *"radix flava Americana."* Rafinesque, 1828, in his *Materia Medica,* devoted much space to the drug, while the early commentators on American medicinal plants slightingly mentioned it. The editor of the *Thomsonian Recorder,* 1833, added it to the Thomsonian materia medica, and Wooster Beach introduced it in his practice, but the drug was neglected by the first edition of the *United States Dispensatory,* 1833. The second edition, 1834, gave it a slighting reference, which was carried, unchanged, for ten years. *The Electic Dispensatory,* King and Newton, 1852, made Hydrastis conspicuous, and it thereafter became much employed, becoming official, in 1860, in the Pharmacopoeia of the United States.

Fig. 2.
Leaf and Flower of Hydrastis.
(One-third Size)

During this entire period the drug was abundant, the price ranging from eight cents to twelve cents per pound. I knew of one lot of 15,000 pounds offered in Cincinnati about 1870, at eight cents a pound, but refused. However, even then, far seeing people perceived that the march of civilization must soon result in the extermination of this uuique and helpless American plant. In 1884, in *Drugs and Medicines of North America,* I called attention to the fact that, as a wild drug, Hydrastis must, within a reasonable time, become extinct, and I then not only took steps for self-protection, but advised parties concerned to prepare for the coming famine. Let me quote from the article cited:

Fig. 3.

Map, showing natural distribution of Hydrastis in 1884. Drugs and Medicines of North America. The heavily-shaded portions indicate the territory in which Hydrastis was then abundant. The lighter-shaded portions indicate territory in which the drug was found, sometimes as an article of commerce. The unshaded portions indicate an absence of Hydrastis growth.

The Past and Present Supply.—Only a small area of country can yield the drug in amount sufficient to repay collection at present prices, and of this section of country, but a limited portion actually contributes any of it to the market. It does not necessarily follow, however, that the plant will not disappear in sections where it now grows abundantly, but which have never yielded the drug to commerce. Hydrastis is so sensitive to climatic influence that even a partial destruction of the timber causes it to shrink away, and one turn of the soil by the plow blots it from existence. If it were like Podopyllum, content to thrive in woodland pasture, the future would be brighter; as it is, each year witnesses a shrinkage in area and a loss to the world (without economic return), of this peculiarly interesting American plant. Hydrastis has nearly vanished from the rich hillsides bordering the Ohio river, and is no longer found in the populous sections of our valley. *Drugs and Medicines of North America,* 1884, page 93.

How well the prophecy then made has been fulfilled, is evidenced by the Hydrastis famine now prevailing among those who failed to read the lesson aright.

Concerning the Cultivation of Hydrastis. Contrary to the usual opinion, Hydrastis is easily cultivated, providing the soil be suitable, and the bed kept free from grass, which not only prevents its increase by the delicate adventitious buds on its slender roots, but even smothers the mother plants. For this reason, rather than from the absolute necessity of deep shade natural Hydrastis abounds in rich, soft, loamy woodlands, and consequently, artificial growing must, if success is to be hoped for, recognize these conditions. Scientific study and care in the artificial cultivation of the drug will unquestionably improve on natural methods, but nature is an excellent teacher. In this connection, the experiments of Dr. H. T. Grime, of New Carlisle, Indiana, are very interesting. He writes me, in substance, as follows, his letters bearing date of November 10, 1906, and May 1, 1908:

Cuttings in boxes five feet above the geenhouse floor, well mulched with rotted horse manure and sawdust, grew thriftily. In ordinary hothouse benches, the plants close together grew so fast as to exhaust the soil in one month. I never saw such rapid growth and such early maturity. I discarded wild soil, because of its contamination with insects, worms and other pests, snails being the worst, replacing same with artificial soil fertilized by henyard refuse, ashes, butcher-shop waste and bone manure. The cuttings started in the greenhouse were transferred to rows in this artificial garden, which was shaded by beans on poles with barrel slats overhead, as well as by fruit trees, with grapevines planted at frequent intervals. Occasionally the plants were sprayed by Bordeaux Mixture. The result proved that the Hydrastis grew rapidly and unfortunately exhausted the soil quickly, being in this respect *worse than tobacco.* Many of the leaves grew to the exceptional size of twelve inches in diameter.

Character of the Rhizome. Fresh, full-grown, wild Hydrastis rhizome is from $1\frac{1}{2}$ inches to 2 inches in length, and from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch in diameter, usually subdividing if of $1\frac{1}{2}$ inches in length. (Fig. 4.) It then not infrequently forms knotty clumps.

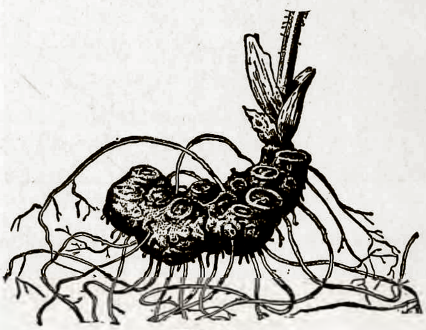

Fig. 4.
Rhizome of Hydrastis.
(One-half Size)

When dry, the diameter is from $\frac{1}{8}$ inch to 1-3 inch. (Fig. 5.) The weight of the fresh rhizome, with attached roots, averages from 80 to 175 grains, but in drying it loses about two-thirds of its weight, or even more. After a growth of from four to six years, the rhizome gradually decays at the older extremity, while at the growing end it creeps through the earth, after the manner of Trillium. The older portions are inferior in quality, hence great age is not accompanied by a proportionate increase in size. Seventy prime, full-sized, green Hydrastis rhizomes (wild), gathered by me October 20, 1907, weighed eighteen ounces. Sixty, of inferior quality, weighed ten ounces.

Fig. 5.

Increase by Root Buds. In studying natural clumps of Hydrastis in the woodlands, I was struck with the fact that the patches under the beech trees, where it luxuriated to best advantage, spread uniformly outward in the woodlands, creeping often to a considerable distance. Again, a parent stem would be surrounded with plants more or less developed, the sports sometimes reaching several feet from the parent stem. I was somewhat perplexed to account for this method of increase, because it surely had not come from the seed, which are very scarce in their natural condition, being enclosed in a small, red berry resembling a red raspberry that is greedily eaten by birds and squirrels. (Fig. 6.) Nor does the rhizome divide itself. But original experimentation in the Kentucky woodlands, as well as in our cold frames at home, demonstrated that some of the delicate root fibres, creeping close beneath the ground, threw up adventitious buds (Fig. 7),

Fig. 6.
Berry of Hydrastis
(Natural Size)

which became new plants from the decay of the connecting rootlet (Fig. 8). Some of these root fibres spread to a considerable length, often two or three feet, or more, following soil avenues of least resistance, frequently cast up more than one bud from the same rootlet (Fig. 9.) Creeping alongside decaying limbs and roots, even penetrating their substances, the natural plant bed thickens and spreads, regardless of the seed. These, however, when dropped by birds or otherwise scattered, serve as nuclei for new patches, but do not, in my opinion, materially account for the increase of old clumps. Indeed, though propagating by seed is possible in a home-made bed protected from birds and squirrels, I found it necessary, both in a natural woodland of large extent and in my exposed plant beds at home, to bag each clump of green berries, in order to secure seeds enough for experimentation.

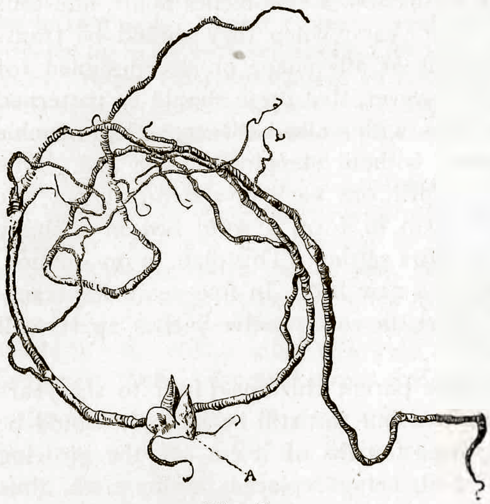

Fig. 7.
(A shows bud on rootlet)

INCREASE BY CUTTINGS. Every full-grown rhizome of Hydrastis is studded with rootlets and many undeveloped buds. As each eye of a potato will, under proper cultivation, make a plant, so each of these Hydrastis buds, provided there be a good root attached, will produce a Hydrastis plant. If a rhizome be sliced transversely into parts, each portion carrying its bud and a few fibrous roots, and these be planted a few inches apart, in rows, in shaded, grass-free beds, in moist soil fitted to its growth, most of the young plants are certain to make a thrifty start, unless an unfortunate drought prevails just after the setting (Fig. 10). Even here, the experience of Dr. Homsher shows that cuttings that have apparently succumbed to untoward conditions, may still be alive, throwing out root fibres and producing a strong underground bud the first season, to come up the second season as vigorous young plants. The rapid rate at which a Hydrastis bed may be increased by means of cuttings is indicated by the fact that the seventy old roots mentioned above yielded 345 eye-cuttings with rootlets, and forty

Fig. 8.
(Bud on rootlet, fully developed)

Fig. 9.
(Young rhizome A, on rootlet, two buds (B and C) set on same rootlet. Rootlet shortened in cut from 18 inches long in order to show buds.)

eyes without fibres. The sixty inferior plants gathered at the same time, yielded 240 eye-cuttings, with rootlets, and seventy eyes without fibres. I have found it best to plant the cuttings an inch beneath the soil, a few inches apart, and thus allow them to remain for two years, when they should be transplanted into rows, or into beds of any shape or size designed for the purpose, it being better, however, that these should be patterned after the manner of flower beds, with walks between, so as to enable a person to reach the center, without stepping on the bed. One thousand cuttings potted in April, one each in a two-inch pot, the whole lot being set in the earth to form a solid bed in a shady ravine, developed nearly the entire setting. This plan, in my opinion, is the best method of starting a new bed. In five years the transplanted plants, six inches apart, in rows twelve inches apart, will be ready for gathering.

Fig. 10. (Cutting of Hydrastis. Rhizome sending up stalk from eye.)

Gathering the Crop. The parent rhizome (four to six years old), after the leaf has withered but can still be located, should be lifted from the earth and three-fourths of it cut off, the growing end, carrying the terminal bud, being replaced in the earth, thus leaving in the bed a full-grown plant to continue the future. In addition, the small plants that have arisen from the rhizome can be removed to new localities, thus rapidly increasing the Hydrastis crop. The parent bed remains thus preserved in a luxuriant setting, the plants themselves, as well as the root buds, contributing to the increase. Had collectors of the natural drug adopted these precautions, the woodlands yet remaining in its native sections, would be studded with beds equal, if not superior, to the original supply. To illustrate the rapidity with which a Hydrastis crop can be produced under favorable circumstances, attention is called to the following letter from a successful grower of Hydrastis, in whose efforts I have been much interested. An eclectic physician, he naturally became concerned in the subject, and listening to my arguments some years ago to the effect that a Hydrastis famine was near at hand, began experimenting accordingly.* (Fig. 11.)

Fig. 11.
Showing woodland Hydrastis culture by Dr. G. W. Homsher, Camden, Ohio.

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* Dr. Homsher was first more interested in *ginseng* than in *Hydrastis* cultivation.

CAMDEN, OHIO, December 1, 1911.

Friend John Uri Lloyd:

You asked me to write you briefly in regard to my experience in the cultivation of Hydrastis.

In the fall of 1903 I commenced the garden cultivation, planting under artificial shade, about 800 to 1000 roots. In 1907 I bought twenty-five acres of ideal woods, had my men cut and grub out the underbrush and prepared my beds, 4½ feet to 5 feet wide, the soil being rich and loamy. In the fall I transplanted all the stock from the garden to its native woods, thus going back to nature. During the year 1907 my men succeeded in gathering about 5000 wild plants, which I divided and planted, six inches each way, in rows. Every year since, I have added from 5000 to 8000 plants.

As regards cuttings, I will say that I find it is best to *break* (not cut) the roots, and to see that sufficient fiber roots are left with each piece of root. My cuttings are accomplished in September. The next spring, it may be that not more than half of the plants from these cuttings come up, but the *second* year, nine-tenths of these young plants send up a top. I have found cuttings to send out strong fiber roots during the summer and germinate a bud, *although no top appeared until the following year.* After the cuttings are placed, the beds should be well mulched with rotten wood or decayed leaves, not too heavy, about one and a half inches thick. (See photographs accompanying.) G. W. HOMSHER, M. D.

RECAPITULATION. Hydrastis Canadensis can be easily cultivated, and after the time necessary for the maturity of the beds, may prove a profitable investment, as well as a pleasant avocational side issue for doctors, druggists and others in rural sections.

The photographic views of the woodland beds of Dr. Homsher, together with his report, are fully comprehensive.

The investigations of Dr. Grime demonstrate:

1. That Hydrastis can be propagated by hothouse methods as a quick starter.
2. That the rhizomes, transferred to artificially enriched soil, in a garden shaded by bean and grape vines and a few trees, grew more rapidly than the wild plants.
3. That Hydrastis rapidly depletes the soil, even though it be very rich.

The difficulty at the present time lies in the fact that the natural drug has been exterminated from all sections of the country, thus preventing the obtaining of green plants for cuttings. Parties raising the drug are utilizing the increase thereof to enlarge their own beds. However, most druggists in the Central West can, in their own neighborhoods, obtain enough of the wild plants to make a start (a few plants will answer), and as has been shown by this article, under proper conditions and *care,* the increase will be rapid. A rich, loamy garden, shaded, will answer every purpose, but a deeply shaded natural woodland is ideal.

The greatest trouble with natural woodland cultivation comes from the poacher, who considers everything that grows in the woodlands free, and who loses no opportunity to encroach upon the property of his neighbors, this being particularly true at the present high price of Hydrastis.

Let me say in closing, that the exhorbitant price now demanded for Hydrastis is altogether owing to ordinary man's improvident disposition and destructive vandalism. The present scarcity is unnecessary, but promises to be cruelly lasting, there being seemingly little prospect of cultivated Hydrastis drifting into market in the very near future, in quantity sufficient to bring the price to a normal condition. Without a doubt, cultivated Hydrastis must command a good commercial return, but prices that prevailed in the olden times, of eight or ten cents a pound, will never again be accomplished.

In this connection, I again plead for government and state intervention in such directions as this. If it is proper to preserve a lingering group of bison, or to search the land over for our vanished wild pigeon, why is it not proper to conserve, with the help of the strong hand of authority, America's valued flora from absolute extermination?

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Chapter 4: Good Agricultural & Best Management Practices

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United Plant Savers' mission is to protect native medicinal plants of the United States and Canada and their native habitat while ensuring an abundant renewable supply of medicinal plants for generations to come. Where once herbal enterprises were few and far between, it is now a competitive marketplace. This increased usage, along with habitat destruction, is causing an ever-increasing shortage of wild plant resources, including some of our most treasured medicinal species. We hope that you will join us in this worthwhile and important mission.

Rural Action's Sustainable Forestry program works with private landowners, government agencies, and non-profit partners to promote the development of sustainable and innovative forest management strategies across rural Appalachian Ohio, with a focus on the production and marketing of high-value edible and medicinal Non-Timber Forest Products (NTFP's). Rural Action's mission is to build a more just economy by developing the region's assets in environmentally, socially, and economically sustainable ways.

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