Goldenseal

(*Hydrastis canadensis* L.)

PENNSTATE
1855
College of Agricultural Sciences
Agricultural Research and Cooperative Extension

Introduction

Nontimber forest products (NTFPs) include plant leaves, roots, and fruits, as well as mushrooms, nuts, and cones. Collecting and tending NTFPs can be a great source of income and pleasure.

This publication is the second in a series to discuss the collection and husbandry of popular NTFPs found in Pennsylvania and the region. Here, the medicinal plant goldenseal (*Hydrastis canadensis* L.) is reviewed.

Uses and Commerce

Considered by botanists to be the only living representative of the genus *Hydrastis*, goldenseal or yellow root is a native North American medicinal plant with both domestic and international markets. Medicinal uses for goldenseal as a potent antibiotic and bitter are derived from herbalist, folk, and Native American traditions.

As an antibiotic, the plant is used as a wash for eye and skin infections, as a dental rinse for mouth sores, and in the treatment of colds (particularly in late stages or where bacterial infections might develop). As a bitter, the plant is used to stimulate digestion.

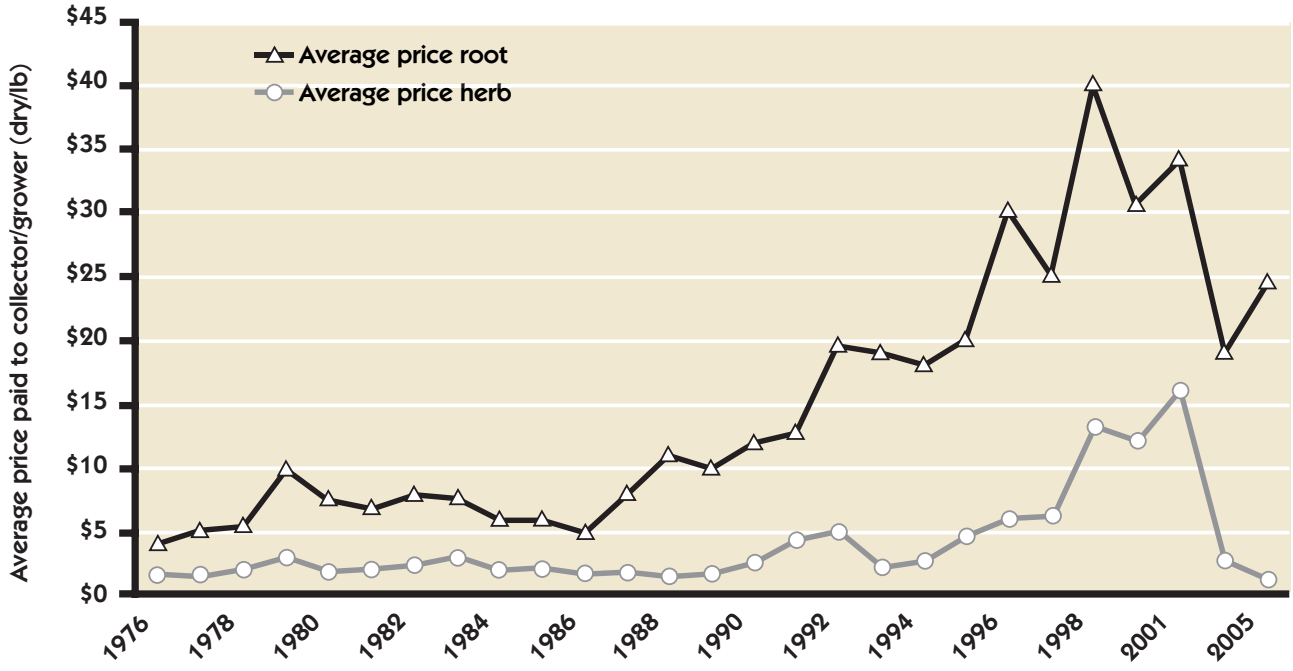
The alkaloids berberine, hydrastine, and canadine are believed to contribute to the medicinal efficacy of goldenseal. These compounds are present in various concentrations throughout the whole plant so that the leaves and stems may be gathered and used along with the root. However, there is greatest commercial demand for the root.

Commercial trade in goldenseal developed in the United States during the mid-1800s. Until recently, most of this trade was supplied from the wild. Concern over the possible unsustainable nature of the industry can be found from the earliest days of commerce, and interest in goldenseal as a "crop" can be traced to the early 1900s as evidenced by a bulletin on the subject produced in 1908 by the United States Department of Agriculture (USDA).

Although early attention was paid to goldenseal as a crop, supplies continue to come from collection. While people enjoy the activity of wild collection (or *wildcrafting*), there are also market factors that discourage more intensive husbandry on forestlands such as *forest farming*. Perhaps the most important factors discouraging commercial husbandry are market and price instability. Figure 1 summarizes the average price paid to collectors and growers over the past 29 years (1976–2005).

Despite price increases (not adjusted for inflation), there is considerable annual fluctuation in price among years. As a perennial crop that takes several years to

Figure 1. Average price of goldenseal (Hydrastis canadensis) *root and herb (1976–2005).*
SOURCE: Various dealer–buyer price lists



mature, such price instability discourages intensive husbandry efforts. Profits from growing goldenseal can be large or small depending on initial investment, scale, yields, and future markets. Those who become involved in goldenseal husbandry should do so for reasons other than only profit since profits may or may not be realized.

Unlike American ginseng for which a premium is paid for "wild" or wild-appearing roots, forest-grown goldenseal has no wholesale "niche" market (see NTFP #1). On the contrary, some buyers have shown a willingness to pay a premium for a cultivated product in recent years. This is due to a variety of factors including concern over source, identity, cleanliness of product, and chemical profile. Growing goldenseal under artificial shade-cloth is not only possible but may result in greater economic returns due to increases in yield and efficiency.

Occurrence in Pennsylvania

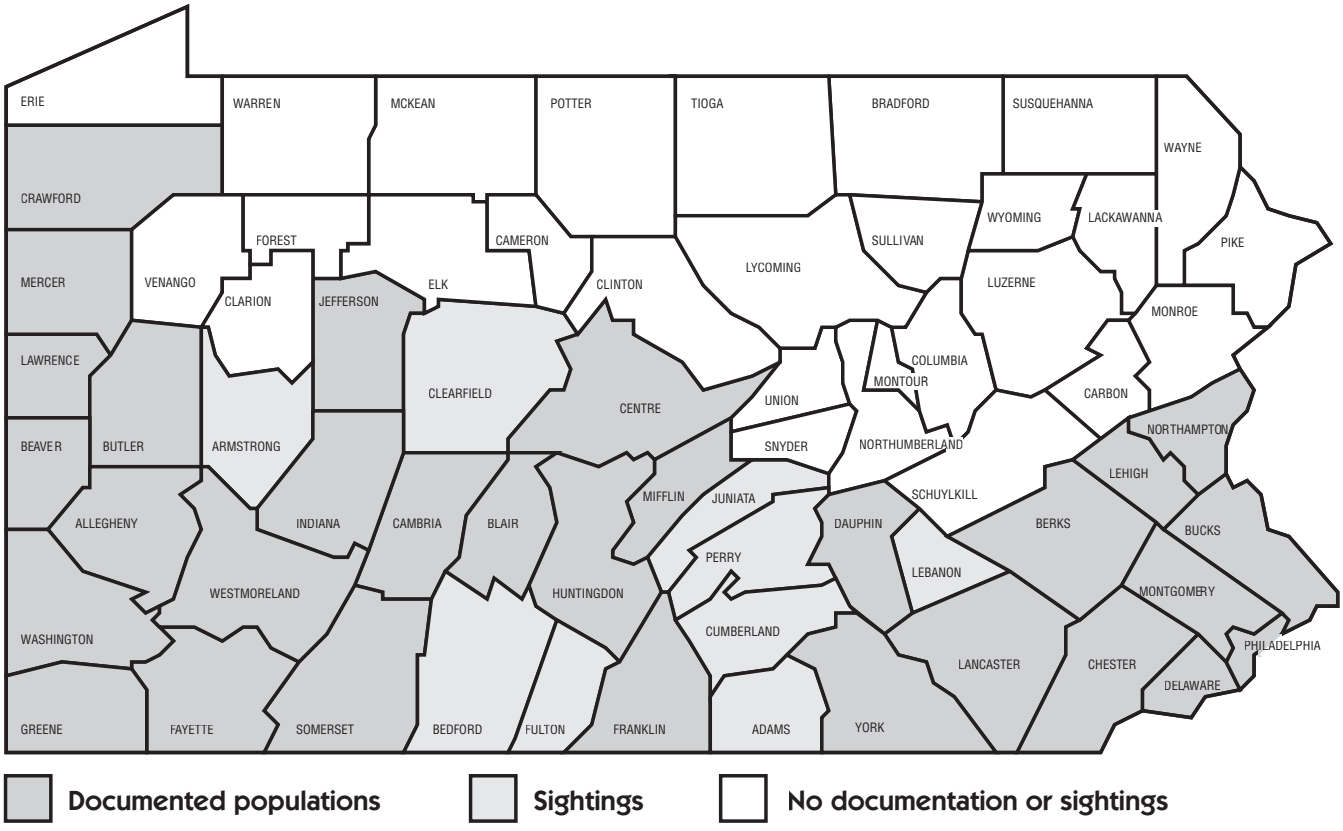
Goldenseal may be encountered statewide in Pennsylvania as a result of past and current planting efforts. However, preserved pressed and dried plant samples, or *herbarium vouchers*, suggest that the natural or "wild" distribution of the species may be limited to the southern and western portions of the state (Figure 2).

Goldenseal appears to prefer loamy soils containing abundant organic matter. While soil pH may vary considerably from one location to another, a slightly acidic to slightly alkaline pH of 5.5 to 7.0 is often associated with vigorous and reproductive populations. Observed habitat is predominantly where seasonal flooding occurs—spring drainages or flood plains. Such locations are wet during spring but generally only moist for the remainder of the year. Occurrences also include upland areas, but such locations are typically seasonally moist, often serving as springtime seeps or drainages.

Growing sites are generally dominated by deciduous trees and shrubs. The over- and midstory forest layers provide 60 to 80 percent shade on more ideal sites. Higher light conditions often lead to stunting and yellowing of plants while low light conditions may slow annual growth and can limit fruit/seed production.

Tree species often observed growing with goldenseal include sugar maple (*Acer saccharum*), tulip poplar (*Liriodendron tulipifera*), red oak (*Quercus rubra*), slippery elm (*Ulmus rubra*), black walnut (*Juglans nigra*), basswood (*Tilia americana*), and ash (*Fraxinus* spp.).

Figure 2. County distribution of goldenseal in Pennsylvania.



Paw-paw (*Asimina triloba*) and spicebush (*Lindera benzoin*) are frequently observed understory shrubs.

Forest herbs found growing with goldenseal in Pennsylvania include jack-in-the pulpit (*Arisaema triphyllum*), black cohosh (*Actaea racemosa*), false solomon's seal (*Maianthemum racemosum* ssp. *racemosum*), black snakeroot (*Sanicula* spp.), enchanters nightshade (*Circaea lutetitiana*), trillium (*Trillium* spp.), wild yam (*Dioscorea* spp.), mayapple (*Podophyllum peltatum*), blue cohosh (*Caulophyllum thalictroides*), Christmas fern (*Polystichum acrostichoides*), and rattlesnake fern (*Botrychium virginianum*).

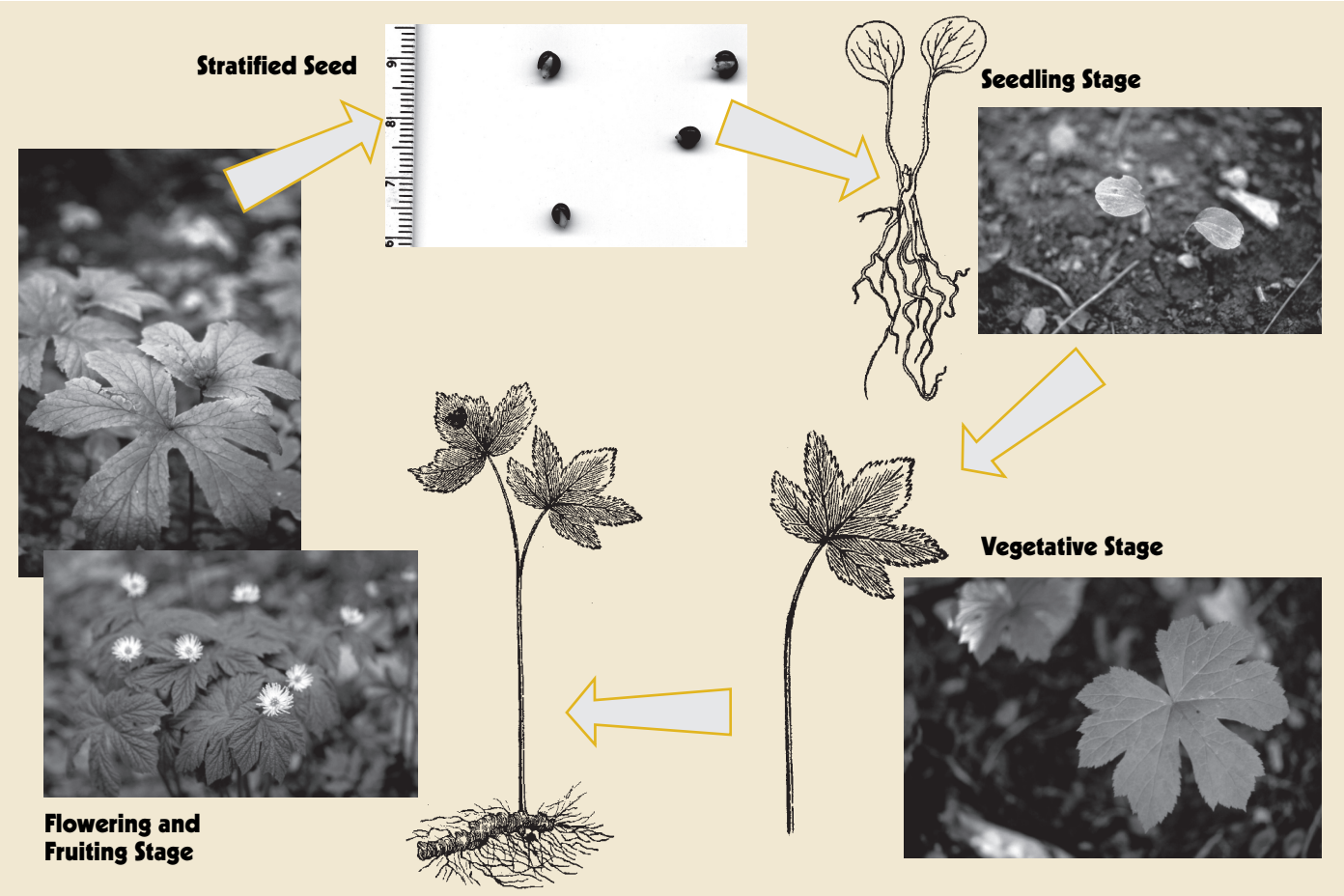
Biology

Goldenseal is a perennial herb that progresses through a series of stages as it develops. Each stage is characterized by differences in leaf number and arrangement. The first stage of development begins following seed germination. During this *seedling stage*, the plant appears with only the seed leaves, or *cotyledons*, present (Figure 3). A goldenseal plant will remain in this stage for one or more years and can be easily overlooked as a result of its inconspicuous size and appearance.

A second, *vegetative* stage is observed during years two or three (and sometimes beyond, depending on growing conditions). Plants in this stage of development are characterized by having a single leaf and lack a well-developed stem. During this stage, the root system begins to branch underground.

A third, *reproductive* stage of goldenseal development is generally attained by year four or five, when flowering and fruiting occur. The leaves during this stage appear in pairs (or occasionally greater) and are *alternately* arranged along the stem, appearing one above the other so as to appear "forked." The lower leaf is generally larger than the upper. The flower and fruit are borne on a short stalk located at the upper-most leaf. This stage is perhaps most obvious in goldenseal because of the general robust size of plants and the presence of flower and/or fruit.

Figure 3. Developmental stages in goldenseal.



Flowering in goldenseal begins just as plants are emerging and leaves are expanding—about late April in Pennsylvania. Goldenseal flowers are eye-catching because the male reproductive structures, the *stamens*, are bright white and yellow. The flowers lack an obvious *corolla* (*petals* and *sepals*)—the parts responsible for giving many flowers their showy appearance.

Goldenseal is both self- and cross-compatible, meaning that plants may set fruit with or without transfer of pollen from another plant. Following fertilization, fruit development proceeds over a period of 8 to 12 weeks with final ripening beginning during mid-July. The fruit upon maturity resembles a small red raspberry in appearance; however, it is rather spongy and lacks the sweetness and juiciness of a raspberry. It is composed of a number of smaller fleshy segments, each containing one or two seeds. Seeds are small (2 to 3 millimeters), black, hard, and shiny.

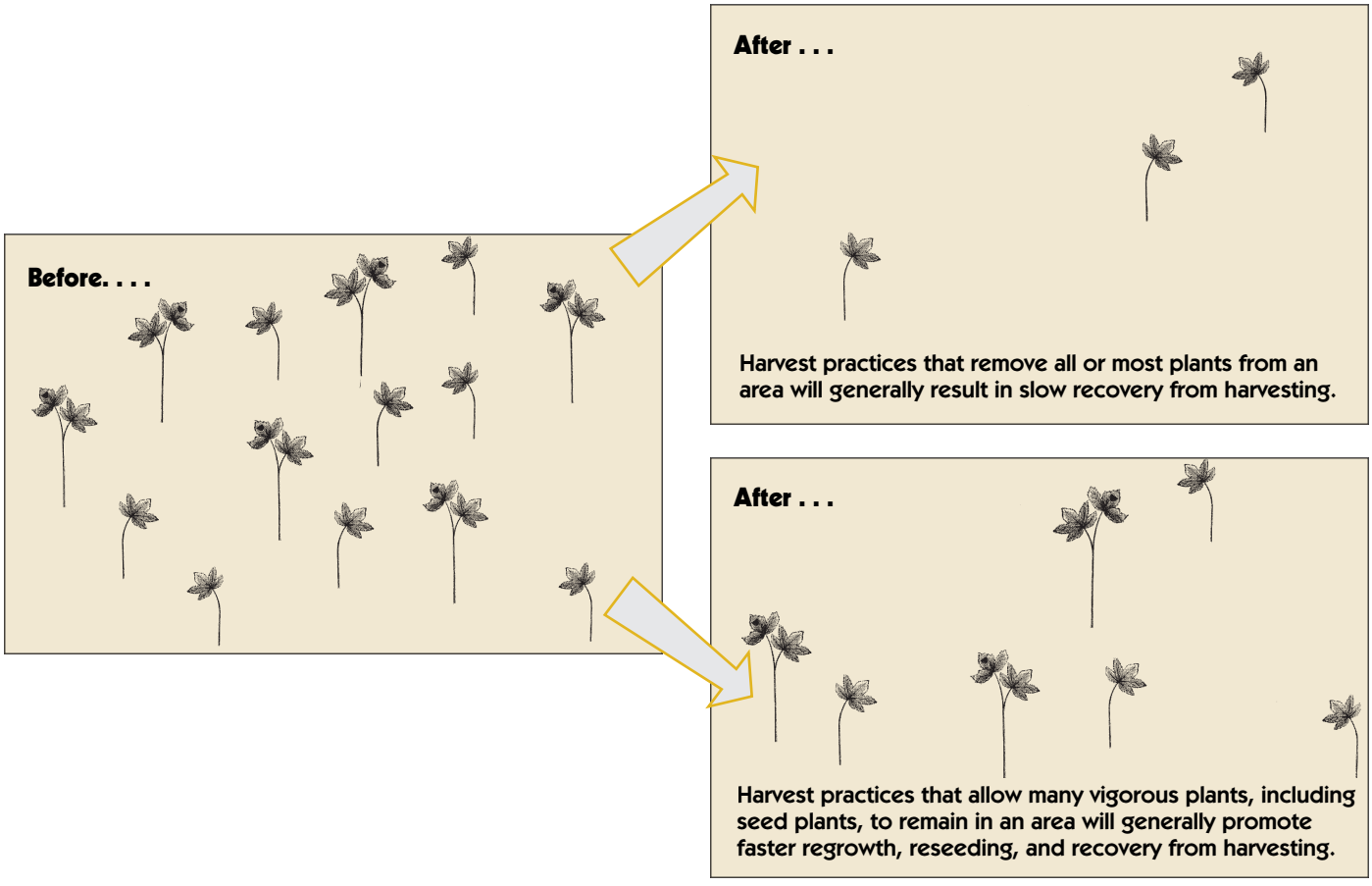
Collection Guidelines

Goldenseal is a colony-forming, or *clonal*, plant, which means that plants are often encountered in "patches" with many stems arising from a single, interconnected root system. Additionally, small lateral roots that separate from parent plants are capable of generating new plants and thereby contribute to patch numbers.

Because goldenseal is clonal and roots can be broken into pieces and replanted to regenerate a patch, retaining seed-bearing plants (i.e., seed plants) may not seem as important to sustainability when collecting from the wild. However, retaining seed plants in an area and waiting for fruit and seed to mature before harvesting is an important component of long-term stewardship since the ability to cross-pollinate and produce seed is an adaptive process in plants.

One general approach to harvesting from wild stands (Figure 4) is for collectors to leave portions of the area and population undisturbed. Following this approach,

Figure 4. The influence of harvest practices on goldenseal population recovery.



a collector would seek to "thin" a patch rather than harvest all available stems, and make efforts to retain both seed-bearing plants (forked stems with two to three leaves) and nonseed-bearing plants (nonforked stems with one leaf). A responsible collector would also replant a portion of the roots back in harvested areas to help with recovery and expansion.

If plants cannot be well spaced because excessive trampling of the patch would result or it is just too tedious or difficult to negotiate, then collection might proceed from the edge of the patch inward. That is, plants around the periphery of the patch might be harvested and extend inward only where gaps exist or are created. While any remaining pieces of goldenseal root or root fibers will help to regenerate the patch, replanting the area with root segments or pieces to allow recovery from the harvest is a good idea.

Before any gathering occurs, the location and abundance of plants in the area should first be determined. If patches have few plants or stalks or show little vigor (i.e., very little growth and flower/fruit production), then plants should not be collected from the area. In such instances, it is best to leave plants alone or to try to encourage numbers in the area by actively planting seed and perhaps even dividing existing plants.

a goldenseal root

Regulations Concerning Goldenseal Collection and Commerce in Pennsylvania

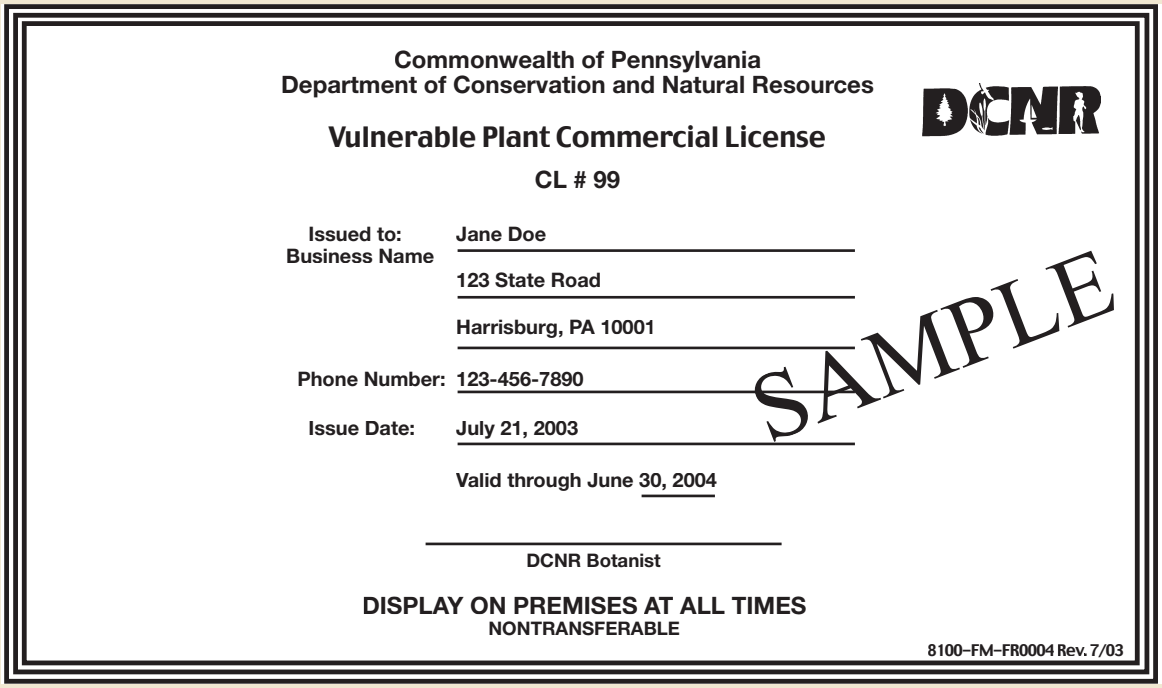
Conservation concerns surrounding collection of goldenseal from eastern forestlands have been expressed for more than a century. Only recently, however, have natural resource management agencies in the United States taken action to promote goldenseal stewardship and conservation as well as regulate the "wild" industry.

The most significant regulatory action has been the 1997 addition of goldenseal to Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). The purpose of this international treaty is to protect wild plants and animals from overexploitation by humans. The U.S. Fish and Wildlife Service (USFW) is the federal agency responsible for implementing CITES in the United States. The USFW's Division of Scientific Authority (DSA) and Division of Management Authority (DMA) are responsible for ensuring that exports of goldenseal are legal, and that harvest is not detrimental to the survival of the species in the wild. Both DSA and DMA use information provided by exporters of goldenseal to make their findings, which include documentation of legal collection, status of wild goldenseal, and/or cultivation information.

Goldenseal collectors and growers in Pennsylvania are not required to maintain records of their activities if the product is intended to be sold to a buyer within Pennsylvania or the United States; USFWS record-keeping requirements presently only apply to those who plan to export goldenseal from North America. (*Note:* This is a very different program from that of American ginseng in which both interstate and international commerce records are required by USFWS and states, and those who handle ginseng [dealers, collectors, growers] are therefore asked to provide information about their activities at the county, state, and federal levels.) If gathering or producing goldenseal under contract for an exporter, one may need to maintain records for the benefit of the exporter.

In Pennsylvania, an important goldenseal management step was taken during the late 1980s with the Wild Resource Conservation Act. This act directed Pennsylvania's Department of Environmental Resources (DER)—the predecessor of the current Department of Conservation and Natural Resources (DCNR)—to identify endangered, threatened, and vulnerable wild plant species and to issue regulations governing their taking, possession, transportation, exportation, processing, and sale.

Figure 5. An example of a vulnerable plant license issued in Pennsylvania to dealers of vulnerable plants. Sellers of goldenseal should always verify that buyers have a current license to ensure that the state's goldenseal trade is tracked for management purposes.



Commonwealth of Pennsylvania
Department of Conservation and Natural Resources

DCNR

Vulnerable Plant Commercial License

CL # 99

Issued to:
Business Name: Jane Doe
123 State Road
Harrisburg, PA 10001

Phone Number: 123-456-7890

Issue Date: July 21, 2003

Valid through June 30, 2004

SAMPLE

DCNR Botanist

DISPLAY ON PREMISES AT ALL TIMES
NONTRANSFERABLE

8100-FM-FR0004 Rev. 7/03

The DER issued regulations in 1987 under "Conservation of Pennsylvania Native Wild Plants," which established a recognized special status for wild plants recognized as *vulnerable plants* to include plant species "in danger of population decline within this Commonwealth because of their beauty, economic value, use as a cultivar or other factors that indicate that persons may seek to remove these species from their native habitats." Three species are presently included in this category: goldenseal, American ginseng (*Panax quinquefolius*), and yellow lady-slipper orchid (*Cypripedium calceolus*).

Buying, trading, or bartering plants listed as *vulnerable* is prohibited within Pennsylvania without first obtaining a vulnerable plant license (Figure 5). This license is granted on an annual basis to any interested individual provided he/she complies with record-keeping requirements. The DCNR oversees this program and uses information collected by licensed dealers to track the quantities of goldenseal and other vulnerable plants collected for commerce from Pennsylvania forestlands. These statistics are obtained through buyer–seller transactions and so the accuracy of both collector and dealer reporting is an important aspect of the program.

The management of goldenseal in Pennsylvania as a vulnerable plant continues to evolve in response to new scientific information, federal requirements, and public and industry input. For the latest information on management of goldenseal in Pennsylvania, contact the PA DCNR Wild Plant Program and/or visit the PA DCNR vulnerable plant Web site (see "For Further Information" at the end of this publication).

Where to Collect

Theft or poaching of goldenseal from public and privately owned forestland can be a problem. Those who collect goldenseal without permission from landowners and/or managers can affect both the viability of the species, by interfering with management and stewardship practices, and the medicinal plant industry, by tarnishing the image of goldenseal collectors within the public perception. Collectors should always consider the broader impact that their actions may have on continued harvest and trade of species within Pennsylvania.

No prohibitions exist against goldenseal collection from privately owned forestlands, assuming that *one*

is either the owner of the forestland or has obtained permission from the owner. If there is any doubt regarding who owns a particular parcel of land, then efforts should be made to determine ownership prior to removing plants. Collectors should recognize that developing and encouraging goldenseal interests with landowners can often yield great partnerships. Such relations can, for example, ensure that the goldenseal resource is acknowledged in any land management decisions (e.g., logging and road building) that would impact the ability to collect from the area again. Discussing one's interest in the goldenseal resource with the property owner is therefore not only ethically appropriate but may also ensure that one has a place to collect for years to come.

On some public lands in Pennsylvania—state forest and national forestlands, for example—collection is prohibited without permission from the local management office. Such consent is typically granted in the form of an annual fee-based permit, which entitles collection from a designated area. State land management authorities may withhold permits for a given year in order to allow plant populations to recover from harvesting and/or to monitor or study plant populations. Decisions regarding whether to allow collection during a given year are made on an individual management unit basis.

Collection of goldenseal from state parks in Pennsylvania is not permitted. These areas are intended to serve as places where the public can enjoy nature through observation. Similarly, collecting goldenseal from state game lands in the Commonwealth is unlawful.

It is very important for the reputation of the goldenseal industry, as well as for continued appreciation and study of goldenseal in the Commonwealth, that collectors abide by these prohibitions. Those who collect from areas without first receiving permission not only face penalties for their activities, they are also tarnishing the image of root collectors as a whole.

Forest Farming

Forest farming is a type of agroforestry practice in which an existing forest ecosystem is managed or modified to yield a "crop" or multiple "crops." Goldenseal husbandry on private lands via forest farming can be a reliable and profitable means of obtaining product for personal use or commercial ends.

Propagation Guidelines

Goldenseal may be grown or propagated from root pieces and seed. In general, producing a marketable root from large root pieces takes less time (i.e., 3 or more years) than producing from seed or small root fragments (i.e., 5 or more years).

FROM ROOTSTOCK

Goldenseal has the ability to grow from very small root pieces. Even fragments that break off in the soil are capable of generating a new plant. The most reliable method of propagating goldenseal is by dividing the root into ½-inch pieces or larger, each preferably with a well-developed bud. Divisions should be carried out during late summer or early fall as the plants are going dormant. Planting of root pieces can be carried out virtually anytime during the year, although fall and spring are most preferred.

Another method of growing goldenseal is by replanting the small root fibers or pieces found along the main root. These fibers often break off during root harvests and if left in the soil (either on purpose or inadvertently) can result in future *volunteers*. Smaller root pieces may remain dormant during the year after planting and will generally require a longer period to yield a harvestable root. However, they are often abundant on bigger, well-developed roots and with a little patience can help reduce (re)planting costs. Some growers maintain separate beds for growing out these fiber roots and small root pieces before transplanting to production beds or into local habitats.

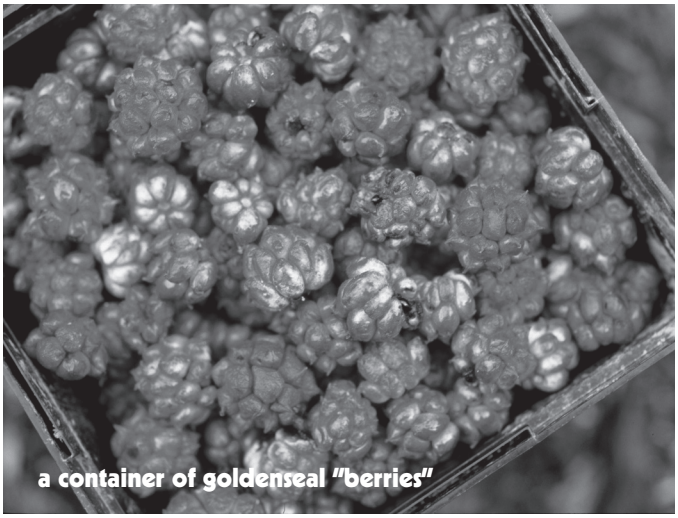
Root pieces of any size should be planted 2 to 3 inches deep, with the bud (if present) oriented upward. When planted in beds, keep a close eye on overwintering plants to ensure that frost heaving and/or soil settling does not expose roots, which results in freeze injury or mortality. This can be particularly problematic during the first year after beds are formed.

FROM SEEDSTOCK

Goldenseal fruit ripens to a deep red color beginning in late July in Pennsylvania and can at that time be collected and immediately planted about ½ to 1 inch deep. Alternatively, the seed can be removed from the fruit and handled separately. If gathered fruit are soaked in water for 24 to 48 hours, the seed is more easily removed because the surrounding fruit tissues become softened or partially disintegrated. Seed can then be separated by rubbing fruit pulp against a screen or similar roughened surface until the hard, black seeds are freed.

Once seed is separated, a period of exposure to cold temperatures is required before germination will occur. The process is referred to as *cold-stratification* and is a requirement for many temperate forest plants, shrubs, and trees. Seed can be exposed to low temperatures naturally (by planting in forest soil/beds) or artificially (by refrigeration at 35 to 40°F). Some of the best germination success occurs when collected fruit and seed are immediately sown. Whatever method is followed, seed *must* remain moist during the process.

Even when temperature and moisture requirements are met, germination is unpredictable and often staggered over time, with new seedlings appearing the first spring after sowing and continuing to appear for years thereafter. Because goldenseal seed is presently very expensive (and sometimes difficult) to buy, growing goldenseal from seed stock is generally not advised for beginners. Rather, those new to goldenseal husbandry should establish initial planting trials from rootstock and then gather seed from these plantings for experimentation.



a container of goldenseal "berries"

Husbandry Options

In forest farming of goldenseal, two basic methods may be followed: (1) the *woods-cultivated* and (2) the *wild-simulated* methods. The woods-cultivated method requires labor and time because it involves practices such as the use of raised beds, fertilizers, and pesticides. The wild-simulated method follows a less-intensive strategy requiring nothing more than the planting of root and seed.

There are market factors to consider in any commercial venture with goldenseal (such as those discussed on pp. 2 and 3). These factors are most important for those who would need to make a significant initial investment in money, time, and labor in order to establish commercial-scale plantings. However, with a strong interest, some planning, and a good business sense come opportunities to generate both income and pleasure from forest goldenseal production.

WOODS-CULTIVATED GOLDENSEAL

The woods-cultivated method of growing goldenseal takes advantage of the natural forest ecosystem for shade and microclimate, but also alters forest conditions to provide habitat for goldenseal establishment and growth. This approach generally involves more investment in equipment, materials, time, and labor than the wild-simulated approach. The most important component of this method is the use of raised beds. Raised beds allow for concentrated plantings around which establishment and maintenance activities can be effectively centered. The woods-cultivated method can be used to establish plantings that then provide a source of seed or transplants for wild-simulated stocking efforts.

Before setting out to create raised beds, a grower must consider the suitability of the terrain for site improvements, especially if he/she plans to use farm or garden equipment. Beds established on slopes may compromise safety or site integrity (e.g., soil erosion). Similarly, areas where many tree roots or large rocks occur at the soil surface are usually inappropriate for intensive husbandry. These obstacles create difficult and hazardous working conditions for mechanical tillage.

A general method for creating a raised forest bed is to till or dig an area to a size slightly larger than the desired bed width and use the outside soil to build up or hill the center. For example, to create a raised bed with a desired width of 4 feet, the grower would need to dig an area of 6 to 8 feet wide and use the outer 1 or 2 feet, respectively, of loosened soil to mound the center of the 4-foot-wide bed. The additional soil is used to create a rounded or domed bed, which will allow the bed to more readily

shed excess moisture during a rainstorm. Beds should be shaped and allowed to settle for as long as possible ahead of planting in order to reduce chances for winter heaving of roots or seed.

Once the bed is shaped, the soil may be amended with crushed limestone for pH adjustment. While a range of pH values is associated with wild goldenseal growing sites in Pennsylvania, a target pH of 5.5 to 6.0 is recommended based on available experience and growing trials. Adjusting soil pH is certainly not necessary, but it may improve growth and chemical profile and/or reduce disease problems. Using other soil amendments such as fertilizers is not advised. The exception is an occasional application of well-rotted sawdust or compost.

One thing is clear from both grower experiences and research trials: Growing goldenseal in raised beds usually benefits root growth and thus yields. These benefits may arise from the looser, more easily colonized soil conditions or from some other factor. Raised beds also mean that plants can be grown in a convenient and organized manner. The main disadvantages to this method are potential increases in the incidence of disease and pests and greater investments in materials and labor.

WILD-SIMULATED GOLDENSEAL

The wild-simulated method involves thinly sowing seeds or transplants in the forest environment and allowing these to grow with minimal human influence. In this approach, the strategy is to establish and maintain populations as "wild." It is the easiest and least expensive method to follow, but it is also the most unpredictable. Depending upon preference and motivation, little care and maintenance may be involved, with the chief investment being for planting stock. With wild-simulated plantings, the importance of forest site selection is very important since there will be little effort made to "improve" habitat.

Once a wild-simulated grower has identified a promising location, he/she may need to thin out some of the vegetation from the forest area(s) before planting. The goal is to remove any potentially interfering plants without adversely altering both the quality and ecology of the site. In this regard, the grower may choose to remove any undesirable tree or shrub species in keeping with the overall management objectives. Caution must be followed since removing too much of the over- or midstory may expose the location to too much sunlight.

a woods-cultivated goldenseal garden

It may also increase germination and competition from other plants.

Little or no soil preparation is carried out in the wild-simulated approach. Instead, seeds or transplants are either (1) individually hand-planted ½ to 1 inch deep; or (2) the leaf litter is carefully brushed aside, seeds/transplants are sown, and the leaf material put back in place. If done properly, the former method has the benefit of being less disturbing to the site and can be easily accomplished. However, this method requires more time since each seed or plant must be individually situated. By taking such care, establishment success may be improved.

Ideally, the planting of seed or roots should be done in late summer through autumn. While, ultimately, the plants might be grown at a low-density spacing in order to reduce the incidence of fungal diseases and other pests, the initial plantings should be close since plants may be lost over time. For example, while the final spacing may be roughly one plant per one square foot, the initial seeding rate may be as much as two to four seeds or transplants per square foot. Where survival is good and overcrowding is cause for concern, plants can be moved or thinned.

In subsequent years, disease, insect defoliation, and animal browsing are allowed to take their toll on wild-simulated plantings as a means of thinning and culling the stand. Any vegetation that appears after planting may be weeded periodically to reduce competition. Additional seeds and seedlings may be planted, perhaps yearly, to ensure a continuous annual harvest once the minimum age threshold is reached and to replace any seedlings lost to slugs or other pests. On favorable sites, however, additional seed and seedling recruitment is likely to come from existing plants as they attain reproductive age.

The wild-simulated approach for goldenseal has several disadvantages. The first is the length of time it takes to obtain a harvestable root from seed or transplants. The time may be 2 to 3 years longer than for the woods-cultivated approach. The second, and perhaps more important, disadvantage is that the yield per root (and thus per pound) tends to be lower than that from woods-cultivated plantings. Unlike American ginseng, for which there is a "premium" for wild-appearing roots, goldenseal has no such premium. Thus, quantity (in terms of yield) is just as important as quality, and practices that affect yield also affect profitability. For this reason, the use of raised beds in a goldenseal forest culture (i.e., woods-cultivated approach) is generally recommended as this practice tends to promote more luxuriant and rapid growth and productivity.

Woods-Cultivated Versus Wild-Simulated Goldenseal: Costs and Revenues Compared

Before starting any enterprise, gathering information about costs, yields, and other factors that may affect profitability is important. An enterprise budget is a simple financial tool that can be used in this process. In developing enterprise budgets, remember that one is estimating future revenues and that their actual value may differ due to future market uncertainties. To address potential uncertainties, one can change any numbers, such as yields or prices, to see how profitability is influenced.

The following example enterprise budget gives the costs and revenues for both a woods-cultivated and a wild-simulated goldenseal forest farming venture on a $^1/_{10}$-acre piece of forestland.

Woods-Cultivated Goldenseal

COST ASSUMPTIONS

Planting stock:

- when grown from transplants: $1,620
- when grown from seed: $510

One-tenth of an acre (about 4,350 square feet) provides enough room for nine 5 by 80 (width by length) raised beds. Using this arrangement, each bed would be 400 square feet of planting space for a total of 3,600 square feet of planting space. The remainder of the area (about 750 square feet) is used as walkways and to accommodate tree roots, watercourses, boulders, and so forth.

Because germination is not a factor with transplants (although survival is), one might calculate planting needs based on a final desired spacing of one plant per square foot. With 3,600 square feet of planting space, one's transplant needs would thus be 3,600 plants. Typically, suppliers provide a discount on purchases of a large number of transplants. An average price for a two-year old transplant, including any such discount, is estimated as $0.45. The total cost for 3,600 transplants at $0.45 each is $1,620.

If one chooses to establish goldenseal from seed, then a different set of cost assumptions apply. Plantings from seed will require at least 5 years of growth to yield a marketable root. If one chooses to start from seed, two seeds per square foot might be planted for a requirement of 800 seeds per bed (2 seeds by 400 square feet). This

assumes an average germination rate of 45 percent (0 to 90 percent has been observed) so that approximately one out of every two seeds might be expected to germinate and become established. Eight-hundred seeds per bed multiplied by nine beds suggest a total requirement of 7,200 seeds for a $^1/_{10}$-acre plot. One-hundred grams of seed (1 pound = 454 grams) of goldenseal seed contains an average of 5,000 seeds and costs approximately $340. One-hundred fifty grams (~ 7,500 seeds) at a cost of $510 would be needed to adequately plant all nine beds at a rate of two seeds per square foot.

Labor:

- when grown from transplants: $1,800
- when grown from seed: $2,300

Site preparation and planting will take an estimated 60 hours on $^1/_{10}$ of an acre. Maintenance is estimated at 25 hours per year, or 75 hours for 3 years (from transplant) and 125 hours for 5 years (from seed). In the final year, harvesting and preparing the roots for sale (cleaning and drying) is estimated at 45 hours. Assuming labor costs at $10 per hour over 3 and 5 years (for a total of 180 and 230 hours), the total labor costs are $1,800 and $2,300 from transplant and seed, respectively.

Equipment and materials: **$500**

Equipment such as a rake, digging tools, backpack sprayer, and drying equipment are fixed costs that are a one-time investment and do not increase with acres planted. A rototiller is another fixed-cost item ($700 to $900), which is optional and not included in this example. Costs such as chemicals (fungicides and rodenticides) vary by the amount of land planted and the extent of problems. Costs for these items are estimated at $500.

Total costs:

- when grown from transplants: $3,920
- when grown from seed: $3,310

YIELD AND REVENUE ASSUMPTIONS

Net Revenues: (revenues - costs)

- when grown from transplants: –$3,444
- when grown from seed: –$2,834

Assuming a survival of nearly 100 percent, a resulting yield at one plant per square foot will be about 3,600 plants after 5 years from seed and after 3 years from transplants. Because goldenseal is a colonial plant and will produce additional stalks (and plants) from underground stems (i.e., *rhizomes*) this yield estimate is conservative. It is nevertheless appropriate since all roots will likely not be harvestable and/or some will be saved for replanting efforts.

A reasonable average weight per goldenseal root grown in woods-cultivated systems might be 10 grams (fresh weight). Assuming moisture content of 70 percent (as has been reported), a 10-gram fresh weight root would yield a final dry weight of 3 grams. One pound of woods-cultivated goldenseal root would therefore contain about 150 plants. The total yield of 3,600 plants in this example might accordingly be estimated at about 24 pounds dry weight. Yields per acre under artificial shade have been reported as 100 to 200 pounds per $^1/_{10}$ acre (1,000 to 2,000 pounds per acre). The estimates presented here may therefore be low, but they could be multiplied by 3 to 8 to come up with a range of increased possible yield values.

With historical prices averaging $20 per pound for goldenseal (range $0 to $40) the gross revenues are estimated at $476. When costs from planting stock and labor are subtracted, the net revenues for both seed and transplant yields are negative. In other words, the operation has failed to turn a profit, and this example did not consider the investment's actual value determined by discounting (i.e., future revenues considered in present time).

Wild-Simulated Goldenseal

COST ASSUMPTIONS

Planting stock:

- when grown from transplants: $1,620
- when grown from seed: $510

Costs here are estimated as the same as for woods-cultivated planting stock costs.

Labor:

- when grown from transplants: $1,100
- when grown from seed: $1,300

Site preparation and planting will take an estimated 10 hours on $^1/_{10}$ of an acre. Maintenance is estimated at 10 hours per year, or 50 hours for 5 years (from transplant) and 70 hours for 7 years (from seed). In the final year, harvesting and preparing the roots for sale (cleaning and drying) is estimated at 50 hours. Harvesting wild-simulated roots requires slightly more time because they are not grown in beds, which could make harvesting more difficult. Assuming labor costs at $10 per hour over 5 and 7 years (for a total of 110 and 130 hours), the

total labor costs are $1,100 and $1,300 from transplant and seed, respectively.

Equipment and materials: **$100**

Equipment such as a rake, digging tools, and drying equipment are fixed costs that are a one-time investment and do not increase with acres planted. Total costs here are estimated at $100 since little equipment is required to prepare planting areas.

Total costs:

- when grown from transplants: $2,820
- when grown from seed: $1,910

YIELD AND REVENUE ASSUMPTIONS

Net Revenues: (revenues - costs)

- when grown from transplants: –$2,678
- when grown from seed: –$1,768

Assuming 100 percent survival, the resulting yield with one plant per square foot would be 3,600 plants after 7 years from seed and 5 years from transplants. Again, this yield estimate is conservative because goldenseal is colonial and will produce additional stalks (and plants) from underground stems.

A reasonable average weight per goldenseal root grown in wild-simulated systems might be 3 grams (fresh weight). Assuming moisture content of 70 percent (as has been reported), a 3-gram fresh weight root would yield a final dry weight of slightly less than 1 gram. One pound of wild-simulated goldenseal root would therefore contain about 500 plants. The total of 3,600 plants in this analysis would thus yield about 7 pounds dry weight. Yields per acre under artificial shade have been reported as 100 to 200 pounds per $^{1}/_{10}$ acre (1,000 to 2,000 pounds per acre). The estimates presented here may therefore be low, but they could be multiplied by 3 to 8 to come up with a range of possible yields.

Historical prices have averaged $20 per pound for goldenseal (range $0 to $40). Gross revenues are estimated at $142. When costs from planting stock and labor are subtracted, the net revenues for both seed and transplant yields are negative. The operation has failed to profit, and this example did not include investment discounting.

Economic Implications

As shown in Table 1 below, comparing the two methods reveals similar conclusions: Forest farming of goldenseal can be risky, assuming a large initial investment in planting stock must be made *and* the price paid per pound of root remains at or below the historical average of about $20. This example does not include discounting, or

Table 1. Comparison of goldenseal forest production costs and revenues when grown from divisions/transplants or seed (for 1/10 acre or 4,350 square feet).

	WOODS-CULTIVATED		WILD-SIMULATED	
	Division or Transplant	Seed	Division or Transplant	Seed
No. years to harvest	3	5	5	7
COSTS				
Divisions/transplants (3,600, 2-year-old)	$1,620		$1,620	
Seed ($^{1}/_{4}$ lb, ~ 7,500 seeds)		$510		$510
Labor	$1,800	$2,300	$1,100	$1,300
Equipment/materials	$500	$500	$100	$100
Total costs	**$3,920**	**$3,310**	**$2,820**	**$1,910**
REVENUES				
Yield (dry lbs)	24	24	7	7
Price received per dry lb	$20	$20	$20	$20
Total revenues	**$476**	**$476**	**$142**	**$142**
NET REVENUES ($)	**-3,444**	**-2,834**	**-2,678**	**-1,768**

adjustment for changes in dollar value over time, which would further reduce the present value of crops–particularly following the wild-simulated method, which will generally require more time in order to yield a marketable product.

In the enterprise budget developed in Table 1 on the previous page, low but realistic yield and price estimates were used. A more favorable scenario showing profit potential is provided in Figure 6. High reported yields (about 200 pounds per $^1/_{10}$ acre) and a high historical wholesale price ($40 per dry pound) are used as estimates. This scenario is only shown for woods-cultivated goldenseal since wild-simulated yields would generally be expected to be lower given that practices that tend to promote higher yields, especially if the use of raised beds is not followed.

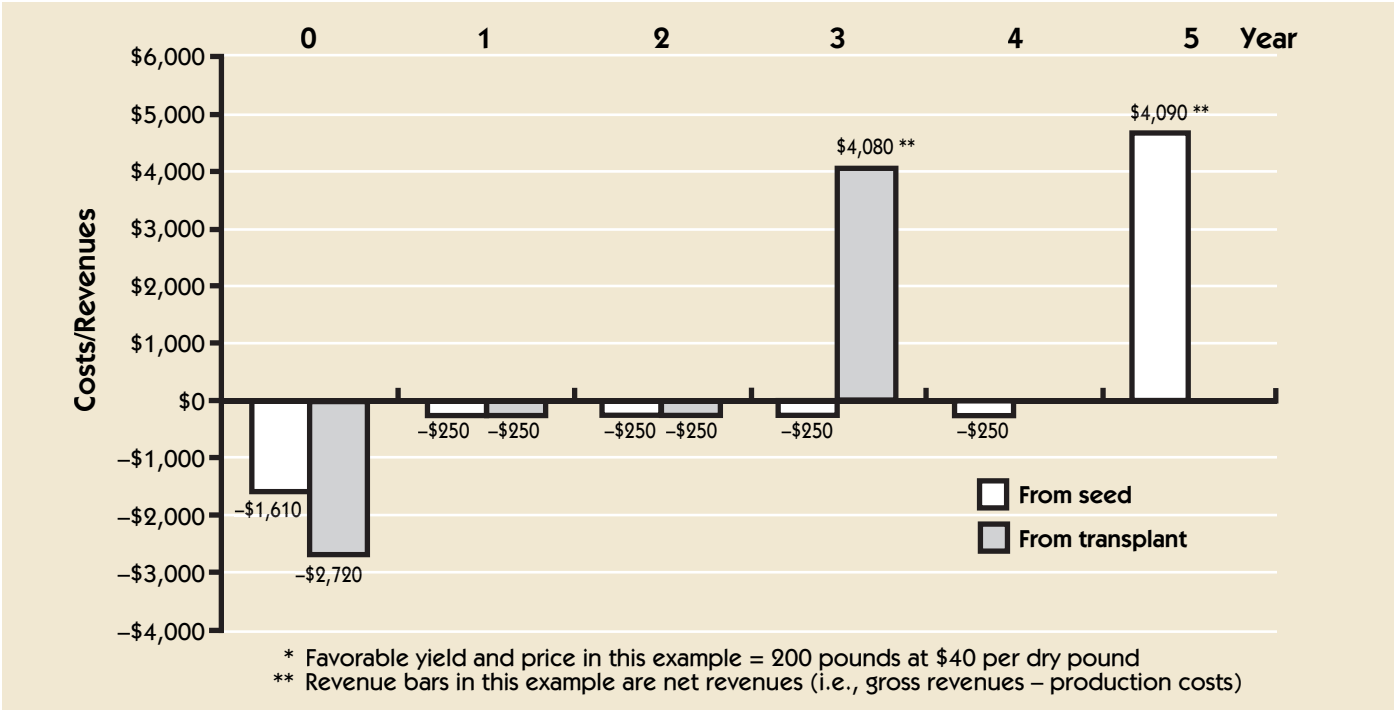
Whether plants are grown from seed or transplants, Figure 6 illustrates that profits in goldenseal forest farming are possible. Though decent revenues can be realized, the fact remains that forest farming of goldenseal still remains risky in the absence of "favorable" yields and markets. This illustrates the need for careful deliberation and planning, as well as staying informed of market conditions and opportunities to take advantage of peak prices.

The economic comparisons presented here are examples and are included only to serve as a guide in planning a forest farming operation. They do not account for any benefits resulting from economy of scale (i.e., cost savings as scale of operations increase) or any losses caused by animals, slugs, insects, fungal diseases, weeds, and/or theft. Yields will also vary depending on site conditions, use of soil amendments, and other cultural practices. Many of the labor costs in these examples can be modified or eliminated altogether, for increased profitability.

Competition from artificially shaded, field-cultivated goldenseal operations will likely assure that prices remain at or below historical averages. This is a conservation success of sorts as there will be less interest in collection, but it also lessens some of the opportunity to be competitive at small-scale forest farming of goldenseal. While there is a strong consumer demand for goldenseal, the market is exhaustible.

The major costs in the budget presented here are incurred from purchased planting stock. If seed or root could be obtained through legal, ethical, and responsible collection (on one's own woodlot, for example), then these costs would be greatly lowered, further enhancing the prospects for profit and enterprise viability. Alternative sources of planting stock such as collectors or other growers may also be another way to reduce planting stock costs since they may offer stock by the pound at going market value. The cost estimates used in these examples were

*Figure 6. Cash flow example for woods-cultivated goldenseal husbandry operations on $^1/_{10}$ of an acre (~ 4,350 square feet) that assumes favorable yield and price.**



based on nursery supplier quotes, which are generally much higher than what one would pay per pound for raw product.

Those seriously pursuing goldenseal production on forestlands should explore opportunities with higher profit-generating potential. For example, both seed and transplants are in demand by gardeners and those interested in forest farming, as well as for use in teas and tinctures (alcohol extracts) by local herbalists and health food stores. Direct markets such as these eliminate the "middle man" and boost profits.

Organic certification may represent yet another way to increase profitability. The cost of certification should be considered alongside any increases in income and markets.

Concluding Remarks

For the past century, goldenseal has been a popular native North American medicinal plant. Though still collected from the wild, conservation concerns suggest that those interested in commercial goldenseal exploitation should adopt intensive husbandry approaches such as forest farming. Whatever their reason, those who collect goldenseal should always use caution and restraint when gathering from wild stands. Sustainability of collection from the wild depends on personal judgment and stewardship.

Goldenseal cultivation on forestlands is a risky endeavor due to market factors such as price instability; however, there is still income potential. Those interested in forest farming of goldenseal should strive to keep initial investments to a minimum through active management (seed processing, root dividing, etc.) to increase plant numbers. The adoption of the woods-cultivated approach and, in particular, the use of raised beds is likely to increase yields and perhaps even improve quality. Direct and retail marketing opportunities should be investigated as a means to increase revenues. This includes possibly seeking organic certification, becoming a supplier of planting stock, and pursuing markets in which quality and source is valued above all else. Staying abreast of market trends and knowing when to sell are very important.

Pennsylvanians are fortunate to have goldenseal available to observe and enjoy as a native forest resource. It is in the best interest of all to act responsibly and ethically to maintain a legal and thriving trade in the species. While a forest-based goldenseal industry could be an economic boon to the state, there is also concern that this industry threatens wild plant populations. Only through communication and cooperation between different public sectors can conservation and commerce be achieved. For this reason, collectors, growers, and dealers must all participate in efforts to develop and share information about one of Pennsylvania's most valuable forest assets—goldenseal.

For Further Information

The following Web sites provide further information related to goldenseal.

- Pennsylvania Department of Conservation and Natural Resources (DCNR): contains information specific to goldenseal in Pennsylvania, including publications, educational opportunities, and dealer contact information.
  http://www.dcnr.state.pa.us/forestry/wildplant/vulnerable_plants.aspx
- Pennsylvania Flora Project (Morris Arboretum, University of Pennsylvania): contains information about the flora of Pennsylvania, including publications and educational opportunities.
  http://www.paflora.org/
- U.S. Fish and Wildlife Service (USFWS): information about CITES and listed species.
  http://www.cites.org/
- U.S. Fish and Wildlife Service (USFWS): contains information about how to obtain a permit to export goldenseal from North America.
  http://international.fws.gov/permits/plants.html

The following books are sources of additional information related to goldenseal.

- W. S. Persons, and J. M. Davis. 2005. *Growing and Marketing Ginseng, Goldenseal and Other Woodland Medicinals*. Fairview, N.C.: Bright Mountain Books.
- Cech, R. 2002. *Growing At-Risk Medicinal Herbs: Cultivation, Conservation and Ecology*. Williams, Ore.: Horizon Herbs.

Goldenseal

Index

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814-865-6713.

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Produced by Information and Communication Technologies in the College of Agricultural Sciences

Code # **UH175** 5M3/06mpc4768