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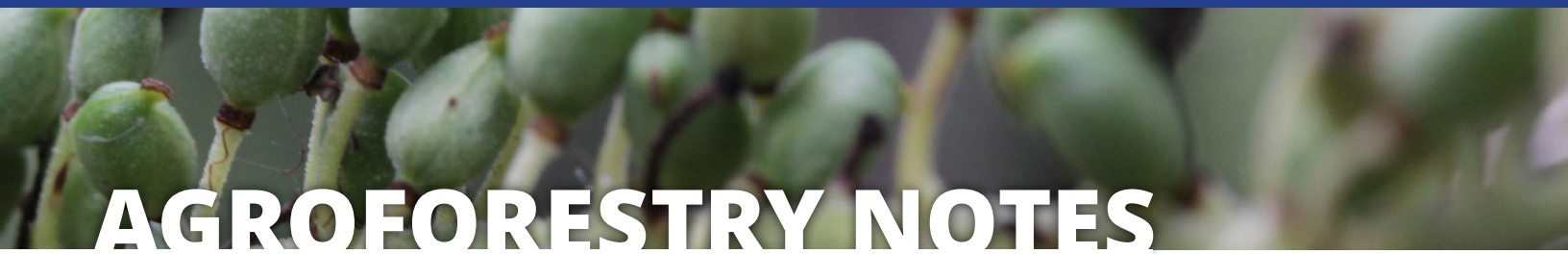

AGROFORESTRY NOTES

Forest Farming: An Agroforestry Practice

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Introduction

The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Forest Farming Conservation Practice Standard (379) defines forest farming as "managing or establishing stands of trees or shrubs in coordination with the management and/or cultivation of understory plants or nontimber forest products [NTFPs]" (USDA NRCS 2022a). The intentional management of vertical space and the interactions of plants and microclimate distinguish forest farming from recreational or opportunistic harvesting.

Forest farmers may create intensive, cultivated systems or manage existing plant populations in more extensive systems to enhance production, yield, and marketability of desired species. In different contexts, many terms such as multistory cropping, forest gardening, tree home gardens, and food forests are used to describe forest farming practices. These terms reflect the different emphases, uses, or designs of these systems.

While trees themselves may provide marketable timber or carbon sequestration benefits, the primary products of interest in many forest farming systems are known as nontimber forest products (NTFPs). These can come from any part of the structure of a forest and include all products other than wood and its allied products. NTFPs are derived from understory plants, fruits, nuts, barks and fibers, leaves, grasses, fungi, and other biological materials (Chamberlain et al. 2018).

This introductory forest farming Agroforestry Note focuses on the production and management of herbaceous, understory NTFPs. These crops represent only a fraction of NTFPs across a diverse range of forest farming systems. Many of the considerations and approaches presented here may apply to or be adaptable across different landscapes and forest farming systems. However, each situation is unique, and many regionally specific factors for land managers to evaluate in forest farm design and implementation are beyond the scope of this note.

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Banner Photo: Black cohosh seeds. Photo by Priya Jaishanker.

Objectives

Forest farmers are often motivated by one or more of the following objectives:

Economic: Forest farmers can harvest NTFPs for sale in direct, wholesale, or other markets. By producing raw materials or value-added products, forest farmers can create a new source of income on their farms. Forest farming may present an opportunity to grow crops on longer timelines or in a less intensive way than annual agriculture. For those who also manage annual crops or timber production, forest farming allows for income diversification and risk management in the case of field crop failure or losses due to timber pests and disease. It also offers opportunities for management and production during periods when labor needs for other farm activities are low, and it may use land previously considered unproductive. Many forest-cultivated crops cannot be produced in open fields or are produced at a much lower quality, even under shade cloth (Davis and Persons 2014, as cited in Chamberlain et al. 2018). In these ways, forest farming can complement other parts of a farm operation or managed forest to produce new income sources.

Ecological: Forest farmers can improve forest health and conserve resources by actively managing their land for species diversity and ecosystem services. NRCS recognizes the following conservation purposes of forest farming per Conservation Practice Standard 379: improving crop diversity and terrestrial habitat, building soil health, and increasing plant/tree community diversity—including native species (USDA NRCS 2022a). Active forest management can have other ecological benefits such as reducing invasive species, increasing awareness of pest and disease issues, and enhancing wildlife habitat. Cultivating forest products intentionally can also reduce harvesting impacts on wild populations of NTFPs on public or other land (Chamberlain et al. 2021).

Social and Cultural: In addition to selling to markets, forest farmers can harvest diverse NTFPs for personal, family, or shared communal use. Forest farming can be a way to cultivate plants with cultural importance. These include NTFPs with cultural value to Tribes and Indigenous Peoples, who may use Indigenous land stewardship practices including traditional ecological knowledge to cultivate those NTFPs. Innovative approaches to land access, such as long-term leases for forest farming and forest farming on public lands, also offer opportunities for forest farmers. Such arrangements are increasingly common and can help forest farmers gain affordable, long-term land tenure, provide a caretaker on the land for absentee landowners, increase property values, create rewarding livelihoods, and build skills and experience, among other social benefits (Hannum 2017).

Benefits and Limitations

Compared to forestry or farming, forest farming has benefits and limitations including:

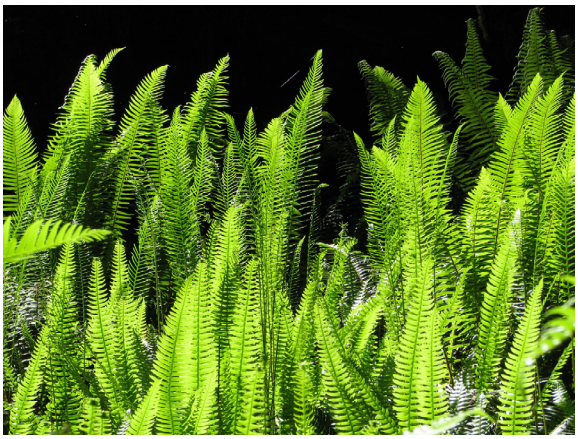
Benefits:

- Increased biological diversity compared with most annual cropping systems
- Forest ecosystems protected from conversion to other land uses
- Additional and diversified income from forested land
- Potential production of high-value crops that cannot grow well elsewhere
- Carbon sequestration (depending on context)

Limitations:

- Less market information available compared with many crops and timber
- Relatively small, potentially volatile markets
- Requirements for unique labor skills and broad knowledge of plant interactions
- Potential investments in new equipment and labor systems
- Possible limitations and uncertainties with crop insurance programs

Forest Farming Products



Western swordfern (*Polystichum munitum*) has a range of cultural and practical uses for Indigenous communities of the Pacific Northwest. Photo by Eric T. Jones.

Commercially traded NTFPs are often categorized into broad market segments including culinary products, medicinal and dietary supplements, decorative and craft items, and nursery and landscaping products (see table; Chamberlain et al. 2018).

Culinary Products: Foods harvested from the forest include the fruits, nuts, leaves, sap, tubers, bulbs, and roots of many plant species, as well as fungi that inhabit dead wood or emerge from underground mycelia in forest systems. Berries, nuts, mushrooms, and maple syrup are well-known culinary forest products.

Medicinal and Dietary Supplements: Many forest plants used for their therapeutic value are marketed as medicines or dietary supplements. To be marketed as medicines or drugs, plants must be tested for safety and efficacy and meet strict U.S. Food and Drug Administration (FDA) standards. Otherwise, they are legally considered food items and product labels cannot claim any medical benefits.

Decorative Items and Crafts: From local craft fairs to internet marketplaces, a multimillion-dollar industry comprises fine arts and crafts made from NTFPs. Artisans may craft baskets from willow branches and the bark of paper birch, carve bowls from burls and other deformities, sculpt vines into statues, and much more. End uses for many forest-harvested floral greens include fresh and dried flowers, aromatic oils, boughs and greenery, basket filler, wreaths, and roping (Chamberlain et al. 2021).

Nursery Stock and Landscaping: Forest farmers can sell live plants as bareroot stock or balled live plants for use in horticulture and ecosystem restoration. Forest farmers may also harvest and sell the seeds of forest species to various markets. Foraging of forest understory wildflowers for horticulture sales is common in many areas of the country. Forest farming of these species may provide additional market opportunities while reducing impacts on wild plant populations.

These market segments are a good way to categorize NTFPs, but many species have multiple uses and may end up serving several markets. For example, beargrass, native to the Western United States and Canada, has longstanding cultural, spiritual, and practical importance for American Indians who have historically weaved its leaves into baskets, roasted its rhizomes for food, and boiled its roots to make medicines. It is sold today for use in ornamental landscaping and floral arrangements (USDA NRCS 2024). Similarly, Indigenous communities in the Pacific Northwest have historically used western swordfern for ritual purposes, medicine, food, and bedding and flooring material. Today, it has commercial value for use in floral arrangements, landscaping, and erosion control in conservation planting (Zouhar 2015).

Major nontimber forest product market segments with examples of prominent species, U.S. regions where they are most prominent, and the plant organ used

Market segment	Species[1]	Common name	Region	Organ
Culinary	*Acer saccharum*	Sugar maple	Northeast, Southeast	Sap
	Allium tricoccum	Ramps, leeks	Northeast, Southeast	Whole plant
	Boletus spp.	Bolete mushroom	Northwest	Fruiting body
	Pinus edulis, P. monophylla	Pinyon pine	Southwest	Seeds
Medicinal and dietary supplements	*Arnica cordifolia*	Arnica	Northwest	Whole plant
	Oplopanax horridus	Devil's club	Alaska	Roots
	Panax quinquefolius	American ginseng	Northeast, Southeast, Midwest	Roots
	Serenoa repens	Saw palmetto	Southeast	Fruit
Decorative items and crafts	*Abies balsamea*	Balsam fir	Midwest, Northeast, Southeast	Boughs
	Gaultheria shallon	Salal	Northwest	Leaves
	Xerophyllum tenax	Beargrass	Northwest	Leaves
	Betula papyrifera	Paper birch	Midwest, Northeast	Bark
	Callitropsis nootkatensis	Yellow cedar	Alaska	Wood
	Hierochloe odorata	Alpine sweetgrass	Northeast	Stem
Nursery stock and landscaping	*Abies fraseri*	Fraser fir	Southeast	Tree
	Arctostaphylos columbiana	Hairy manzanita	Northwest	Shrub
	Cypripedium spp.	Lady's slipper	Southeast	Orchid
	Echinacea purpurea	Purple coneflower	Great Plains	Herb

[1] Some species may have multiple uses for multiple markets.
Adapted from Chamberlain et al. (2018).

Forest Farming Approaches: Intensive vs. Extensive

There are many approaches to forest farming, each with varying levels of design complexity. One way to categorize these approaches is along a continuum of management intensity. More intensive approaches maximize production in small areas and may significantly modify existing plant populations. Extensive approaches involve limited modification of natural plant populations across large sites. Which approach is right for a given forest farming enterprise depends on many factors including—but not limited to—labor capacity, NTFP market demand, and the ecological and production objectives of the forest farmer.

Intensive Forest Farming

Intensive forest farming systems aim to support the growth of large, high-density plantings of a desired crop, maximizing site production. These systems may require significant material and/or labor inputs. If harvesting herbaceous, understory NTFPs, forest farmers may remove obstructions such as stumps, rocks, and big roots; till the soil or construct raised beds; and add soil amendments such as lime and phosphate. Seed or rootstock is densely planted and heavily mulched with straw, composted sawdust, hardwood bark or leaves, or other materials (Chamberlain et al. 2021). Some forest farmers add fertilizers, pesticides, and herbicides to enhance the production of NTFPs. High-density and monocultural approaches can increase production per unit area but also result in greater vulnerability to disease outbreaks.

Yet not all intensive forest farming systems are single-species plantings. Forest gardening involves the cultivation of multiple layers of trees, shrubs, herbaceous crops, and ground cover together. If established on cleared land or cropland, a forest garden may at first approximate an early-successional forest but may take on characteristics of older or multi-aged forest stands over time, depending on management objectives. Overstory trees are typically more widely spaced in forest gardens than in other types of forest farming systems so that light can reach all layers of understory crops. These systems are characterized by high levels of species diversity and often feature many vertical layers of vegetation (University of Missouri Center for Agroforestry 2024). In forest gardens, species are often planted together intentionally in ways that fulfill an ecological function, and they often produce edible, medicinal, or other useful NTFPs. Forest garden management typically involves significant manual labor and specialized knowledge due to the diverse range of species in the system.

Fairy wand (*Chamaelirium luteum*) patch with wire to protect the roots from vole damage. An example of the woods-grown method, an intensive forest farming system. Photo by Katie Trozzo.

Extensive Forest Farming

In extensive forest farming systems, site preparation is minimal and may be limited to raking aside leaves to expose the soil or modifying the forest canopy to favor the growth of desired NTFP species. Some forest farmers may ameliorate the soil with organic fertilizer but generally do not use chemical fertilizers. Seeds of desired species are broadcast, and the plants are allowed to grow with little or no maintenance. Planting density is relatively low so that plants have room to grow and do not compete for nutrients (Chamberlain et al. 2021).

Some extensive approaches to forest farming do not involve sowing or planting. With careful attention to species life cycle traits, reproductive capacity, growth rates, population size, and other factors, forest farmers may selectively harvest wild populations of understory herbs, fungi, or other desired NTFPs in a way that ensures the long-term sustainability of existing populations (Rural Action 2023).

Bloodroot (Sanguinaria canadensis) cultivated in an extensive system designed to mimic natural growing conditions and require little maintenance. Photo by Catherine Bukowski.

American ginseng (*Panax quinquefolius*) grown with the wild-simulated approach, a more extensive form of forest farming. Photo by Priya Jaishanker.

Extensive systems may be less productive than intensive systems. Research indicates that a half-acre of woods-cultivated (intensive system) American ginseng would yield approximately 300 pounds of dried root, while a half-acre of wild-simulated (extensive system) American ginseng would yield approximately 80 pounds (Davis and Persons 2014). However, extensive forest farming systems often require lower input and labor costs and may produce high-quality products that appear similar to plants harvested in the wild. A natural appearance is particularly important for American ginseng markets (Vaughan et al. 2011). Extensive forest farming systems more easily support mixed-species polycultures, which can be less susceptible to fungal diseases and pests.

Planning a Forest Farm

Like other agroforestry practices, forest farming can be part of conservation or production plans on a farm or forest. See Agroforestry Note #48, "Non-timber Forest Products and Forest Stewardship Plans," for one example of this integration.

The following planning steps outline some of the key considerations before beginning a forest farming enterprise. Due to the relatively long timeframes involved in the cultivation of many forest-farmed species, it may take years to become acquainted with a particular NTFP and achieve desired objectives. Therefore, forest farmers may choose to start small and expect to make modifications along the way.

Step 1: Identify objectives.

Determine which NTFP(s) to produce and why. Is the goal to harvest NTFPs for personal or family use, or cultural or commercial purposes? Perhaps NTFP production is part of a conservation plan to preserve wild plant populations and increase species diversity. If cultivating NTFPs as a source of income, researching existing or developing NTFP markets (local, regional, national, or international) is critical. Could these markets easily become saturated? Is it in the forest farmer's interest—and labor capacity—to do value-added processing of the product? If so, what equipment is required, and how much does it cost to purchase and maintain? It is also important to determine the scale of production that may be necessary to enter the market. Depending on the available land, this may inform the management approach needed for a viable enterprise (i.e., intensive vs. extensive system).

Step 2: Conduct a site inventory to assess opportunities and constraints for desired NTFPs.

Each forest farming situation is unique. Environments vary with ecological regions, and site conditions differ from south to north, east to west, and low to high elevations. Understanding specific microclimatic conditions and limitations is critical in determining what plants will grow on a site and how to grow them.

To identify a site's suitability for the desired NTFP species, first characterize the site by documenting the slope, aspect, soils, drainage, light, and plant species growing in the area. The presence of indicator species can provide insight into the environmental conditions of a site and its suitability for certain crops. In the Eastern United States and Canada, for example, species like sugar maple, spicebush, and maidenhair fern are commonly found growing near American ginseng, black cohosh, bloodroot, goldenseal, and ramps (Rural Action 2023). In some regions, conservationists have developed tools to assist in evaluating site conditions for specific species, such as PlantShoe, which evaluates sites for black cohosh, bloodroot, goldenseal, and ramps. A national-scale tool, the USDA NRCS Web Soil Survey, allows users to define an area of interest and explore soil maps and other data. The Soil Survey includes NRCS Ecological Site Descriptions, which can help users identify species that may grow well on a given site.

Many herbaceous understory NTFP species tolerate a variety of soil types, although poorly drained, heavy clays and sandy soils with little organic matter may present challenges and require unique and careful species selection. When conducting a site assessment, collect soil samples and have them tested for nutrient content and other qualities. Often, cooperative extension agents, conservation districts, or local NRCS service centers can assist with understanding results of soil tests and providing plant suitability information. Understanding soil conditions can lead to improved crop production by informing appropriate plant selection and soil amendment needs. Changing the soil pH and adding fertilizer may increase root growth and yield.

Step 3: Develop a production plan for each NTFP.

Planting and Establishment

It is important to consider what is required to produce an NTFP from the planting to the marketing stages. Will planting stock be necessary? Is this stock available and what is the cost? What operational investments need to be made (e.g., purchase of a dehydrator for log-grown mushrooms or other NTFPs), and when?

Each NTFP species has different needs and may grow according to different annual cycles. Ramps, for example, take advantage of springtime leaf-off conditions to grow and store most of their carbohydrates when the canopy is open. American ginseng, on the other hand, is shade tolerant and grows most vigorously during the summer (Chamberlain et al. 2018). It is therefore critical that forest farmers consider how each NTFP they plan to cultivate fits within their larger operation. If forest farming is intended to complement field crop cultivation on a farm, do NTFP harvest times coincide with periods when labor is in short supply or when cash is in high demand?

Canopy Management

Forest farmers will benefit from developing a canopy management plan tailored to the NTFP species they intend to cultivate. This may involve designing overstory, midstory, and understory canopy composition and density to manage light and address site-specific planting requirements. If working with understory NTFP species, it is useful to consider establishment dates, seeding rates, and spacing requirements—among other factors—when planning the sequencing, timing, and extent of canopy management (USDA NRCS 2022a).

Forest Stand Improvement

The manipulation of tree and shrub species composition, structure, or density to achieve desired forest conditions—i.e., forest stand improvement—can enhance site suitability for NTFP production and create opportunities for timber harvesting. It can also help forest farmers achieve other objectives such as maintaining or improving forest health, water management, wildlife and pollinator habitat, and reducing pest pressure and wildfire hazard (USDA NRCS 2022b). Logs from stand thinning can serve as mushroom substrate or as terrace walls for a hillside plot, and pruned branches can provide shade or protection for beds (University of Missouri Center for Agroforestry 2021). Some forest stand improvement activities may need to be done before NTFP establishment, while some will be done later. It is important to consider the sequence of treatments that must take place to achieve site objectives.

Maintenance

Maintaining desired site conditions within forest farming systems is critical to the long-term success of understory crops and other NTFPs. Forest understories are complex, dynamic ecosystems where light and moisture conditions vary significantly across time and space.

If there is insufficient shade for the desired NTFP species, it may be necessary to plant trees or construct shade structures made of wood, boughs, or shade cloth (University of Missouri Center for Agroforestry 2021). Too much shade or inadequate air circulation may require thinning the canopy or woody understory.

In general, extensive forest farming systems should require less maintenance than intensive systems because they rely on natural forest conditions. However, site-specific

factors such as land use history, disease prevalence, predator abundance, and competing vegetation affect the amount of initial preparation and maintenance necessary to keep crops protected and healthy in any system.

Harvesting

When and how to harvest depends largely on the product, as well as the preferences of the land manager. For example, some producers may time harvests of leafy NTFPs to favor certain leaf characteristics for ceremonial purposes, while those growing for wholesale markets may seek to align harvest times with peak market demand. Timing harvests to optimize concentrations of plant nutrients and other components valued in medicinal and dietary supplement markets may also be important. Research on this topic is ongoing (Burkhart and Zuiderveen 2019). Forest farmers will also benefit from considering each crop's propagation requirements. For example, if seed production is necessary, harvest should be delayed until seeds mature.

A general best practice when harvesting vegetation is to leave some material for the plant and to harvest after the major growth period during the year. Stripping all vegetation during the prime growing season could stunt or kill the plant. If the product is belowground, the size of the aboveground portion of the plant can help indicate the relative size of the roots. It is essential to monitor the regrowth and establishment of new cohorts in the population and to take care not to harvest more than a plant can regenerate (Chamberlain et al. 2014).

Marketing

The process of marketing forest-farmed products starts long before the plants are ready to harvest. A good first step is to learn about the different market segments that the products supply. More information is available in Agroforestry Note #45, "**Developing Consumer and Market Research for Non-Timber Forest Products**." In developing a plan, it is useful to include lists of possible enterprises that might purchase the products and understand in what form and preferred minimum volumes the product is most often sold. The **Forest Farming Calculator**, which currently covers six species of forest-grown botanicals, helps forest farmers calculate break-even prices that they must exceed to make a profit selling their crop.

Selling raw materials, marketing value-added products, and agritourism are all ways to generate revenue from forest farming. Selling NTFPs that have not been substantially processed is the simplest and perhaps least risky market option but also nets lower prices. Forest farmers can increase profit by creating a niche in the market and adding value to a product. This could be in the form of drying, grading, packaging, or storing the product and selling it out of season. Value-added options can be done collaboratively with other growers in the area to meet volume requirements, invest in equipment, or overcome other barriers. Marketing services or experiences such as annual festivals in celebration of a product or "pick your own" offerings are two common agritourism approaches that can boost revenues for forest farmers.

For forest-farmed products that may be consumed, it is critical to follow Good Agricultural Practices and abide by relevant food safety rules as outlined by the Food Safety Modernization Act (FDA 2018a). Because manufacturers must follow Good Manufacturing Practices (FDA 2018b), forest farmers who sell to these manufacturers must provide positive identification of all ingredients and certificates of analyses of microbials, heavy metals, pesticides, and other constituents in the products they sell. Forest farmers can add

value to their products by providing voucher specimens for product identification to buyers, certification that the growing area has no contamination, and clean, dry, well-packaged products. The Forest Grown Verified program, administered by United Plant Savers, offers third-party verification of NTFPs grown and harvested in a legal and sustainable manner. Some markets may require USDA Organic certification of NTFPs through the National Organic Program. Depending on costs, organic certification can be a good way to add value to NTFP production.

Conclusion

Forest farming is an agroforestry practice that provides options for land managers who want to support conservation outcomes while cultivating valuable NTFPs. The success of a forest farming operation depends on many factors including site conditions, landowner or community resources and objectives, and access to markets. As markets for medicinal, culinary, ornamental, and other NTFPs have grown, so has pressure on increasingly scarce wild plant populations. This provides both opportunities and challenges for beginning forest farmers. This note is only an introduction to some of the considerations forest farmers may face. For more detailed information, see the resources below.

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