



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Sign up for email updates:
Agroforestry Connection

National Agroforestry Center

Inside Agroforestry

CANOPY CHRONICLES:



LAYERS OF OPPORTUNITY IN FOREST FARMING

Learn more about the American Forest Farming Association on pg. 3

Just started forest farming? Check out the new forest farming calculator on pg. 4

Emerge into spring with mushroom inoculation; learn how on pg. 7



NAC Director's Corner

A commentary on forest farming by Anne Marsh, NAC Director

At a time when many forests are increasingly valued for multiple purposes, the centuries-old practice of forest farming—the cultivation of high-value specialty

crops or forest products below a forest canopy—is receiving renewed interest. Like silvopasture, forest farming allows managers to generate farm revenue while maintaining a forest canopy and supporting stand maturation. Often referred to as multistory cropping or even forest gardening, forest farming can take many forms. It is practiced in rural to urban environments, at multiple scales and cultivation intensities, and supports production of a range of products from medicinal herbs and native ornamentals to fruits, nuts, and other foods such as syrups, ramps, and mushrooms. This versatility has often led to misperceptions and an association of forest farming with individual species. Rather, the practice is grounded in the interaction and management of multiple layers of vegetation for environmental, economic, and cultural benefits.

The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) released an updated Conservation Practice Standard (CPS) in 2022 for Forest Farming (CPS

379) as part of a scheduled process that applies to all NRCS CPSs. The outcomes included a name change (previously it was “Multi-Story Cropping”) and refinements in definition, purposes, and criteria for the CPS. These changes and updates assist NRCS staff, partners, and technical service providers in working with land managers to adopt forest farming for conservation benefits. The National Agroforestry Center (NAC) is committed to advancing research, technical assistance, and training on forest farming as part of USDA’s work to enhance climate resilience and help a diverse array of producers and landowners adopt conservation practices and access new products and markets. Look out for the first national inventory data on forest farming from the National Agroforestry Survey, an updated Forest Farming Agroforestry Note, and new forest farming training opportunities under development with NRCS. Partnerships with other organizations, such as Appalachian Beginning Forest Farmer Coalition and the Northeast Forest Farmers Coalition, are also growing interest in forest farming. It will take many to share expertise and advance practice uptake.

Join us in the exploration of an old practice seeing new light.

Alley Cropping: Case Studies Across Appalachia

Appalachian Sustainable Development, Rural Action, and the National Agroforestry Center collaborated to develop a new publication on alley cropping. This publication is part of a national NRCS Conservation Innovation Grant titled “Increasing Landscape-Scale Adoption of Agroforestry Systems in Central Appalachia through Market-Based Incentives.”

Looking to Keep Up With NAC?

Subscribe to our Agroforestry Connection email update and stay current on new publications, events, and presentations from the National Agroforestry Center! Subscribe at the bottom of NAC's homepage: <https://www.fs.usda.gov/nac/>.

American Forest Farming Association

John Munsell, Virginia Tech

Kate MacFarland, National Agroforestry Center

A new organization—the American Forest Farming Association—is emerging to support farmers and forest managers interested in forest farming. It builds on almost a decade’s work by Appalachian Beginning Forest Farmer Coalition, a group founded with support from the USDA National Institute of Food and Agriculture’s Beginning Farmer and Rancher Development Program.

Since 2015, the coalition has promoted the cultivation and conservation of native nontimber forest medicinal products in Appalachia, a heavily forested region with a long history of wild-harvested edible, medicinal, and decorative materials. It has successfully built out a network intent on expanding production through collective problem solving and grassroots leadership, working with and learning from forest farmers, researchers, technical assistance providers, and others in the forest farming and nontimber forest product community. In recent years, with support from the National Agroforestry Center, coalition leaders have worked to strengthen these relationships and look beyond Appalachia as there is a growing interest in forest farming and its potential to provide products of economic and cultural value. In examining forest farming priorities, challenges, and opportunities in other regions, the American Forest Farming Association became a reality.

The American Forest Farming Association’s advisory committee recently held its first scoping meeting. The association is envisioned as a national professional forest farming organization that focuses on increasing recognition of nontimber forest products as agricultural crops. It will support forest farmers and wild stewards as well as supply stock and value-added nontimber forest product markets. In addition, it will serve as an information clearinghouse, build forest farming education networks and public awareness, and



Forest farming training at the Blue Ridge Center for Chinese Medicine in Floyd, VA. Licensed by Priya Jaishanker/Flickr.

showcase research and precision technology. The association serves all forest farming stakeholders and seeks to advance recognition and support for forest farmers and the crops they produce.



More information can be found at: <https://www.appalachianforestfarmers.org/affa>

The Forest Farming Calculator

Gary Bentrup, National Agroforestry Center

Since 2019, the National Agroforestry Center has worked on a USDA Natural Resources Conservation Service (NRCS) National Conservation Innovation Grant led by Appalachian Sustainable Development titled “Increasing Landscape-Scale Adoption of Agroforestry Systems in Central Appalachia through Market-Based Incentives.” Rural Action, United Plant Savers, Virginia Tech, University of Virginia’s College at Wise, and Radford University are all key partners. This multistate project aims to increase adoption of forest farming and alley cropping in Central Appalachia, including in Kentucky, North Carolina, Ohio, Tennessee, Virginia, and West Virginia.

Through this project, NAC worked with partners to develop the Forest Farming Calculator, a Microsoft Excel-based tool that can be used to calculate the break-even prices for several forest-grown botanicals. This tool estimates the prices per pound of dried roots that a forest farmer would need a buyer to pay to cover the cost of their expenses. To obtain a profit, the forest farmer must seek a higher price. There are currently six species covered by the calculator: goldenseal (*Hydrastis canadensis*), black cohosh (*Actaea racemosa*), bloodroot (*Sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), false unicorn (*Chamaelirium luteum*), and American ginseng (*Panax quinquefolius*).

The calculator is built upon default enterprise budgets derived from the literature. As your operation may vary from the default budgets, you can adjust variables in the default enterprise budget to better reflect your operation or to test the financial impact of changing inputs and expenses.

This tool doesn't require internet access and no information is tracked. However, there are links to additional resources embedded in the tool that will not work unless you are connected to the internet.



USDA Forest Service graphic by Janine Siatkowski.

DOWNLOAD

To download the tool, visit: <https://www.fs.usda.gov/nac/resources/tools/forest-farming-calculator.shtml> or scan the QR Code below:



To learn more, view a video on Appalachian Sustainable Development’s website about how to use the tool at: https://www.asdevelop.org/programs-resources/agroforestry/#Forest_Farming_Calculator

The tool was developed in cooperation with Appalachian Sustainable Development with support from a National Conservation Innovation Grant (NR1 94741 XXXXGO02) from the Natural Resources Conservation Service (NRCS).

Forest Farming Solomon's Seal

Katie Commender, Appalachian Sustainable Development

Tanner Filyaw, United Plant Savers

Andrea Miller, Rural Action

Karam Sheban, Rural Action

Kelsey Siekenn, United Plant Savers

Robin Suggs, Appalachian Sustainable Development

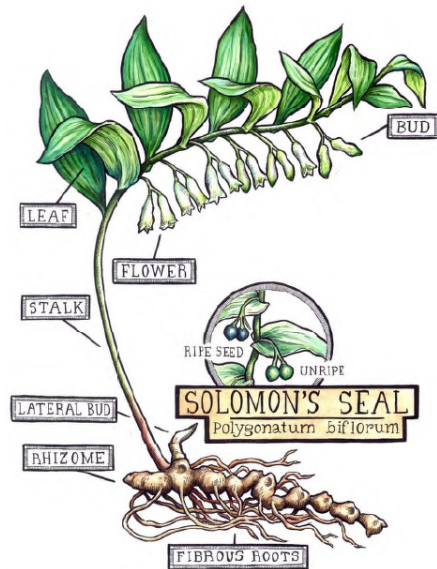
Solomon's seal (*Polygonatum biflorum*), also commonly referred to as "smooth Solomon's seal" and "true Solomon's seal," is a perennial woodland herb that can be found growing in hardwood forests throughout the eastern United States and Canada. Solomon's seal typically begins to emerge in late March or early April, and will continue to elongate and unfurl new leaves for about 1-2 weeks until reaching full size. Plants that are reproductively mature bloom in late spring or early summer, and develop pairs of greenish-white, bell-shaped flowers along the underside of the stem that will continue to bloom for about 3 weeks. If pollinated, each flower will produce a pea-sized fruit that turns from green to purple-blue as they ripen in late July.

Identification & Look-Alike Species

The "true" and "false" Solomon's seal species can be easily differentiated by the location of the flowers on the plant, flower shape, and the color of the ripe seeds/fruits. "False" Solomon's seal has a plume of small, fragrant, star-shaped white flowers located at the terminal end of the stem, and produces a cluster of small greenish seeds/fruits that turn red as they mature in the fall. In comparison, "true" Solomon's seal has pairs of greenish-white, bell-shaped flowers that originate from each leaf node along the underside of the stem, and produces a pea-sized fruit that turns from green to purple-blue as they ripen in late summer.

Propagating Rhizome Divisions & Cuttings

Solomon's seal can be readily propagated by dividing larger clumps of older, more established rhizomes, or by taking cuttings from younger individual rhizomes. The best time of year to make divisions and cuttings is when the plants are fully dormant. Typically the window for successful propagation



Solomon's seal diagram. Licensed by Herbaceous Human/The Forest Farming Handbook.

begins after the first hard freeze in early winter, and lasts until just a few weeks before the new season's growth begins in spring. Identifying and flagging your plantings that are ready for subdividing during the growing season will aid in locating the rhizomes once the tops die down late in the season.

Rhizome Divisions

Rhizome division, i.e. subdivision, is the most reliable method of propagation when working with large clumps of older roots that have been established for many years. When dividing large clumps, use a garden fork to gently loosen and lift the cluster of rhizomes from the soil, taking care not to break or damage the freshly exposed roots. After the clump is fully unearthed, shake off the excess soil and gently work apart rhizomes. By examining the rhizomes closely you should be able to see the slightly flexible, branched joints where each plant wants to separate naturally. Once you have identified the natural point of separation, divide the rhizomes by slightly twisting with your fingers or by cutting with a sharp knife or pruning shears. Ideally, each propagule/rhizome should measure approximately 3" long or more, have a mature or developing

(Continued on next page...)

terminal bud, and healthy fibrous roots.

Once you have produced the desired number of new rhizomes, simply plant them in a prepared production site (i.e. woods-cultivated, wild-simulated, nursery/garden), and cover with approximately ¾"-1" of rich, loose soil. After planting, top dress each bed with 2"-3" of hardwood leaves or similar organic mulching material. If possible, time plantings just before anticipated precipitation to help ensure successful establishment.

This article is adapted from the Solomon's seal chapter of "The Forest Farmers Handbook" by Rural Action, United Plant Savers, and Appalachian Sustainable Development is used with permission. "The Forest Farmers Handbook" is available at <https://unitedplantsavers.org/the-forest-farmers-handbook/>. This chapter was developed in cooperation with Appalachian Sustainable Development with support from a National Conservation Innovation Grant (NR1 94741 XXXXGOO2) from the Natural Resources Conservation Service (NRCS).

Forest Farming in Hawai'i

National Agroforestry Center (NAC) partner Dr. Zoe Hastings Silao of Sustainability Ventures has released seven case studies as part of the project "Agroforestry Outreach on the Hawaiian Islands." In compiling the case studies, Dr. Hastings Silao saw firsthand how communities in Hawai'i are using forest farming to restore landscapes dominated by invasive species, while also producing nontimber forest products of cultural and economic value. Explore a sample of three case studies and their forest farming objectives.

Ku'ia Agricultural Education Center

Ku'ia Agricultural Education Center (KAEC) stewards 12.5 acres of land in Lāhainā that is owned by Kamehameha Schools. KAEC's goal is to restore a portion of the diverse food forest system that Kānaka 'Ōiwi (Native Hawaiians) stewarded prior to European contact, which in Lāhainā was called Ka Malu 'Ulu o Lele (the shade of the breadfruit trees in Lele, another name for Lāhainā). KAEC hopes to restore Ka Malu 'Ulu o Lele to inspire their community to embrace food forest practices and to feed their community with this traditional practice. KAEC is a project of Hawai'i Farmers Union Foundation. KAEC hosts youth and adult education programs and sells fresh produce and value-added products at their local farmers market.

Raffiyy Home Garden

The Raffiyy family stewards three-quarters of an acre of land they own in the Puna district of Hawai'i Island. They grow food, medicine, and materials for making lei, building canoes and houses, and producing other traditional arts. Their goal is to feed and care for their family and perpetuate their culture. As their trees mature, the Raffiyy's look forward to having the materials to teach youth how to make traditional products, like golgol (sennit) from dried coconut husks.

Kaua'i Food Forest

Kaua'i Food Forest is a community-based multistory agroforestry system on the north shore of Kaua'i. Stewardship of the 2-acre food forest is led by the nonprofit organization Regenerations Botanical Garden. The food forest is an educational demonstration site, where community members can gain hands-on experience with agroforestry. It is also a living collection of over 150 different plants that produce food and medicine. Volunteers maintain the food forest and share food, medicine, seeds, and cuttings with the community.

The full case studies and two factsheets about identifying funding sources and the benefits of establishing native plants in Hawaiian agroforestry along with other regional examples will soon be featured on NAC's website: <https://www.fs.usda.gov/nac/regional-examples/index.php>. All case studies from the project are also available in 'Ōlelo Hawai'i, Ilokano, and Spanish language editions and have accompanying videos with closed captions.

Since publication of the case studies, Dr. Zoe Hastings Silao has joined the Forest Service's Pacific Southwest Research Station as a Research Social Scientist, based out of Hilo, Hawai'i. Welcome to USDA, Zoe!

Farming Mushrooms in the Forest: An Opportunity to Grow Something New



A ripe shiitake with gills still curled underneath ready to be harvested. Courtesy photo by Patrick Shults, WSU Extension.

Patrick Shults, Washington State University
Justin O’Dea, Washington State University

While some mushroom production today is done on sanitized sawdust in climate-controlled factories, historically, mushrooms were produced as they grow in nature: on logs beneath a forest canopy. The factory sawdust model while efficient, doesn’t make log-grown operations irrelevant. Log-grown cultivation presents a unique opportunity for farm and forest owners to produce a high-value commodity crop, or at least put something new on the dinner table.

Through ongoing research trials, Washington State University (WSU) Extension hopes to provide answers to regionally specific questions and concerns about mushroom forest farming and ultimately develop a guide catered to the Northwest. This article briefly covers the basic steps, choices, and pitfalls to avoid when getting started growing shiitake (*Lentinula edodes*), a popular log-grown specialty mushroom, either as a hobby or for a commodity crop.

HOW IT WORKS

Saprophytic fungi like shiitake are agents of decay. They live by inhabiting and growing in dead material like wood, feeding on cellulose and lignin, spawning via spores, and leaving behind humus, a layer of decayed organic matter that contributes to forest soils. This is the process people take advantage of when cultivating edible mushrooms. The ultimate prize is the fruiting body of the fungi that forms after successfully inoculating a log.

FINDING SUBSTRATE

“Substrate” refers to the growing medium for the fungus. Most mushrooms need a log from a hardwood (deciduous) tree species. Conifers contain compounds like tannins in their wood that often prevent fungal growth and make inoculation difficult or impossible for certain mushroom species. Many landowners in Washington have access to red alder (*Alnus rubra*), which can serve as a good substrate for shiitake. Other species like cherry (*Prunus spp.*), ash (*Fraxinus spp.*), and oak (*Quercus spp.*) may be used but are less available. Washington’s white oaks have significant ecological value and their habitat has diminished greatly over the last century, so it’s better to avoid harvesting oak for shiitake production in the State.

(Continued on next page...)



A trailer-load of red alder (*Alnus rubra*), sweet cherry (*Prunus avium*), and birch (*Betula papyrifera*) ready to be inoculated. Courtesy photo by Justin O'Dea, WSU Extension.

Logs, also called bolts, should be cut while trees are dormant in winter to early spring before the buds start to swell. Bark slippage can be common on logs that have been harvested while the sap is running, and keeping bark on the log is vital to maintaining moisture. The best bolt size for growing shiitake is between 4–6 inches diameter, primarily for ease of transport. Length is less important, but logs are typically cut into 2–4 foot sections.

INOCULATION

The next phase, inoculation, consists of three steps: drilling holes in the log, filling those holes with shiitake spawn (an inoculated substrate), and sealing the hole. Once felled, inoculate the logs quickly to prevent contaminant fungi getting a head start. Doing this within 3 to 6 weeks of felling is ideal.

Spawn can typically be purchased in two forms: as “plugs” that you insert into holes drilled in the log using a hammer, or as a bag of inoculated sawdust that you pack into the drilled holes with a specialized inoculation tool. Sawdust spawn tends to be more successful and lead to a faster spawn run. WSU Extension research trials found that the strain type of shiitake significantly impacts yields. Wide-range and warm-weather strains do best, while cold-weather strains have less reliable harvests in a summer fruiting regime.

Holes should be drilled in a line every 3–4 inches down the length of the log. Space the rows of holes 3–4 inches apart and ideally offset to create a diamond pattern. After you’ve drilled the holes and inserted your plugs or sawdust spawn, sealing the holes is critical to keeping the spawn from drying out. This is usually done by covering the hole with melted food-grade wax, but foam caps can also be used.

A WAITING GAME

Once the logs are inoculated and sealed, it is a matter of waiting for the fungus to work its way through the entirety of the log. This is called a “spawn run” and often takes 1 to 3 years depending on the size and species of the log, strain of shiitake, and environmental conditions. During this time, stack the logs in a shady area with limited wind exposure to keep them from drying out. Soaking the logs at the start of the spawn run may help with successful inoculation and mitigating moisture loss during Washington’s dry summers.

It’s not uncommon to find some contaminants growing on your logs during the spawn run. Naturally occurring fungus like *Trichoderma* often compete with species like shiitake for dominance and can negatively affect production. Some of this is unavoidable. The biggest concern is letting your logs get too dry, as *Trichoderma* can outcompete shiitake in dry conditions. Covering the logs with humidity blankets during the dry periods of the summer may help reduce moisture loss in logs. WSU Extension is currently conducting research trials to study various moisture management methods.

STARTING THE HARVEST

Knowing the right time to start the harvesting process can be tricky. One way to check is to look at the cut ends of the log to see if there is obvious evidence of mycelial growth, although this is not always indicative of a thoroughly inoculated log. It takes about 1 full calendar year for the spawn run to complete.



An “inoculation station” comprised of a table fitted with caster wheels to hold and rotate the bolt, spawn and inoculation tool, and hot plate to heat up wax for sealing holes. Courtesy photo by Patrick Shults, WSU Extension.

(Continued on next page...)



Bolts placed upright and wrapped in humidity blankets after soaking to provide easy access for harvesting and improve mushroom quality. Courtesy photo by Patrick Shults, WSU Extension.

Harvesting starts by “forcing” or “shocking” the fungus to fruit by submerging logs in cold water for 24 hours. Cold-weather shiitake strains do not respond to force fruiting and generally fruit on their own in the spring and/or fall, but warm-weather and wide-range strains respond well. Soaking should only be done once nighttime temperatures are 45–50 °F to encourage growth. After 24 hours, logs should be stacked in an “A-frame” formation to make harvesting easier. Within 3 to 5 days, the logs will start to form small mushroom heads below the bark called “pins” and should form full mushrooms within 7–14 days. Covering the logs with humidity blankets during harvest can improve quality and protect them from pests. Shiitake is best harvested while the mushroom cap is still slightly curled underneath.

Once the harvest is finished, logs need to rest for 6 to 8 weeks before being forced again. How long a log will remain productive is uncertain, but more frequent shocking will reduce lifespan.

There is a great deal of information available about shiitake log operations, but the vast majority of it has come out of Eastern States. Many of the principles are the same, but it is important to keep in mind that Washington’s climate and tree species for substrate may create different results. Research trials at WSU Extension hope to provide answers to regionally specific questions.



Shiitake log stacks stored under a forest canopy during the spawn run. Courtesy photo by Patrick Shults, WSU Extension.

This article was adapted with permission from “Farming Mushrooms in the Forest: An Opportunity to Grow Something New” by Patrick Shults in WSU Extension’s “Forest Stewardship Notes” posted June 5, 2020: <https://foreststewardshipnotes.wordpress.com/2020/06/05/farming-mushrooms-in-the-forest-an-opportunity-to-grow-something-new/>.



The white marks at the end of the log indicate shiitake mycelium has grown throughout the log. Courtesy photo by Catherine Bukowski.



Shiitake mushrooms stored by the pint, ready for the farmers market. Courtesy photo by Catherine Bukowski.

USDA National Agroforestry Center
1945 N 38th St.
Lincoln, NE 68583-0822

Official Business
Penalty for Private Use, \$300

Address Service Requested

PRSR STD
POSTAGE & FEES
PAID
USDA — FS
PERMIT NO G-40

Upcoming Events

March 22-24, 2024

2024 Gather to Grow Forest
Farming Conference

Roanoke, VA

<https://www.appalachianforestfarmers.org/2024-conference>

April 24-26, 2024

Southwest Agroforestry Action
Network Conference

Tucson, AZ

<https://swaan-site.org/>

May 14-16, 2024

National Adaptation Forum

St. Paul, MN

<https://www.nationaladaptationforum.org/>

"Inside Agroforestry" is published by the USDA National Agroforestry Center and designed by Janine Siatkowski.

Phone: 402-437-5178
Fax: 402-437-5712

- **Anne Marsh**, NAC Director
- **Kate MacFarland**, Forest Service Agroforester
- **Matthew Smith**, Forest Service Research Lead
- **Joe Alley**, NRCS Agroforester
- **Pam Bergstrom**, NRCS Technical Assistance Agroforester
- **Annabelle Moore**, Project & Communication Assistant
- **Sam Feibel**, ORISE Fellow
- **Janine Siatkowski**, Information Assistant

NAC Mission

The mission of the National Agroforestry Center (NAC) is "to advance the health, diversity, and productivity of working lands, waters, and communities through agroforestry." America's working lands — farms, ranches and forests — are facing increasing pressures to maximize production for a growing population while minimizing the impacts to wildlife, soils, water, and other ecosystem services on which we depend. The expansion of crops and other agricultural activities is generating a greater need for these production and protective services. Agroforestry — the intentional integration of agriculture and forestry — has tremendous potential to restore and enhance ecosystem services critical to meeting these needs.

USDA Non-Discrimination Policy

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the

responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.