

# Alley Cropping

## Case Studies in Appalachia



In this alley cropping system, hay is grown between rows of chestnut. Courtesy photo by Ethan Strickley, Swallowtail Forest Farm.

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Alley cropping is an agroforestry practice that involves planting rows of trees and/or shrubs to create alleys within which agricultural or horticultural crops are produced. It is particularly appealing to producers interested in growing multiple crops on the same land to manage risk and improve whole-farm production and profitability. Alley cropping is also supported by the USDA Natural Resources Conservation Service as a Conservation Practice (311). NRCS describes alley cropping as having several conservation purposes, including reducing surface water runoff and erosion, improving soil health, altering subsurface water quantity or water table depths, enhancing wildlife and beneficial insect habitat, increasing crop diversity, and increasing carbon storage.

## Benefits and Limitations

### Benefits

Alley cropping is supported by many conservation programs. Compared with monoculture systems, alley cropping can provide:

- Increased economic diversity, land use efficiency, and overall farm yield.
- Ability to transition to a new enterprise gradually rather than all at once.
- Reduced wind and water erosion.
- Improved pollinator and wildlife habitat.
- Potential for reduced incidence of pests and disease.
- Increased air and soil moisture.
- Increased carbon sequestration.
- Reduced nutrient leaching to groundwater.

### Limitations

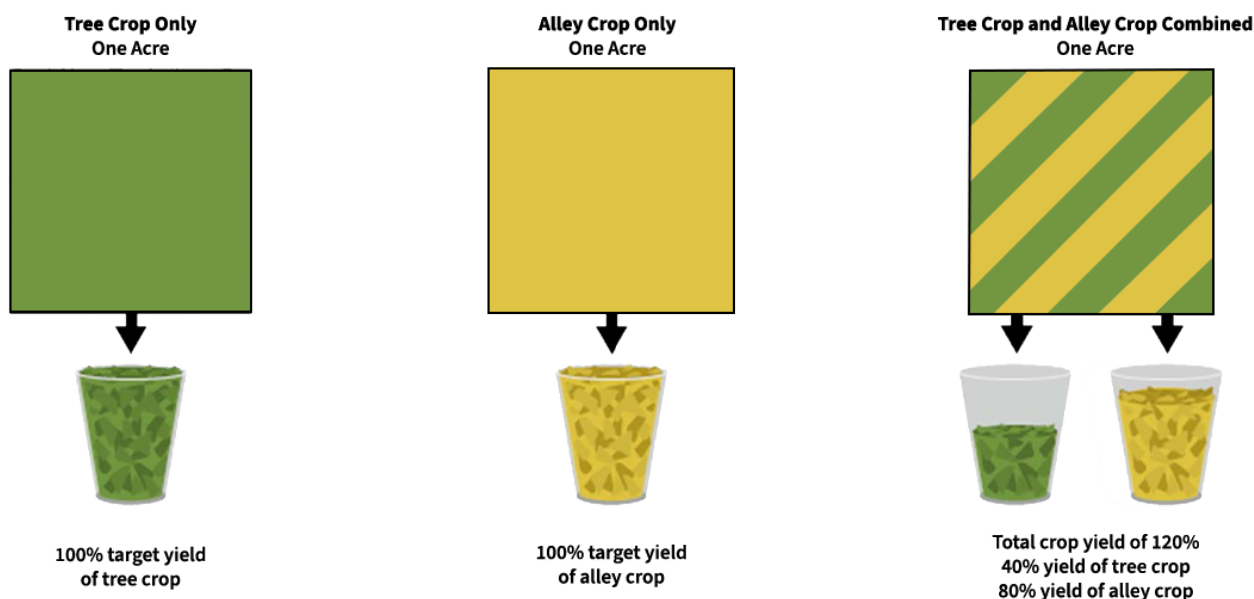
Compared with monoculture cropping systems, alley cropping systems involve:

- More complex pesticide application.
- Competition between trees and crops for water, nutrients, and light.
- Longer time-horizon for cash flow.
- Requires a more diverse set of management skills.
- Possible challenges for equipment use.
- Changing the alley crop options over time due to increasing tree competition.
- Lower crop yields for some commodity crops.
- Capital investment for initial tree and shrub establishment.
- Long-term, secure land tenure.

USDA Forest Service Graphic by Josh Bundy.

By combining multiple crops on the same acre of land, alley cropping can be more efficient than growing crops separately in monocultures. Examining a system's land equivalent ratio is one way of understanding this efficiency. To understand a system's land equivalent ratio, compare the amount of

land needed to grow crops separately in monocultures and get the same yields as under an alley cropping or other polyculture system. Other ways of thinking about efficiency include yield per unit of labor or labor distribution throughout the seasons.



Alley cropping systems may have smaller yields of individual crops, but the yields and efficiency of the whole system may be greater. This graphic portrays the relative yields of three systems: tree crop only, alley crop only, and a combined alley cropping system. This total yield may be higher or lower depending on the crop combination and site. Graphic adapted from Raskin and Osborn 2019.

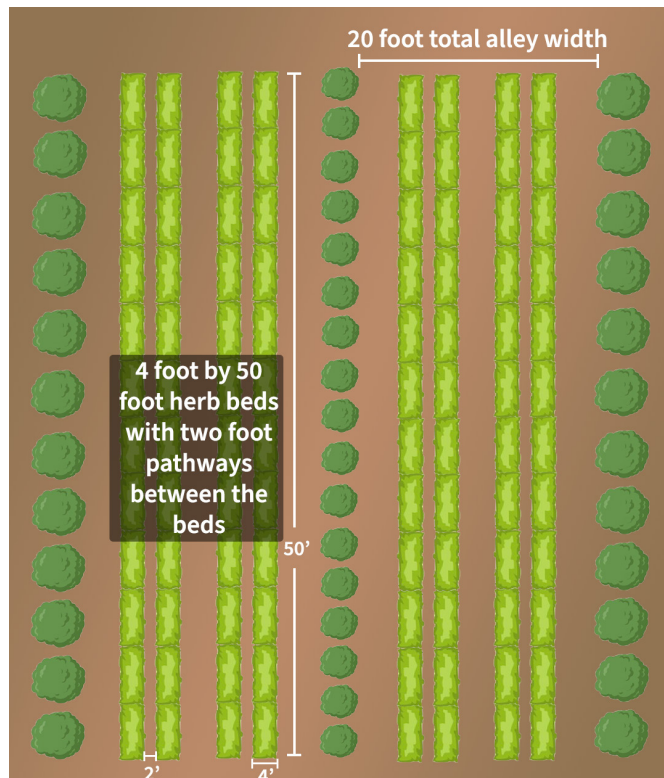


## Design Considerations

Growing a variety of crops in close proximity to each other can create significant benefits to producers and help them manage risk. The tree and crop species should be suited to the soils, climate, and the site. Species and spacing should ensure accessibility for timely management activities, such as spraying, pruning, or harvesting, and should accommodate equipment widths and turn around requirements. Alley cropping designs can range from simple to complex, with single or multiple rows of trees or single or mixed species.

## Management and Changes Over Time

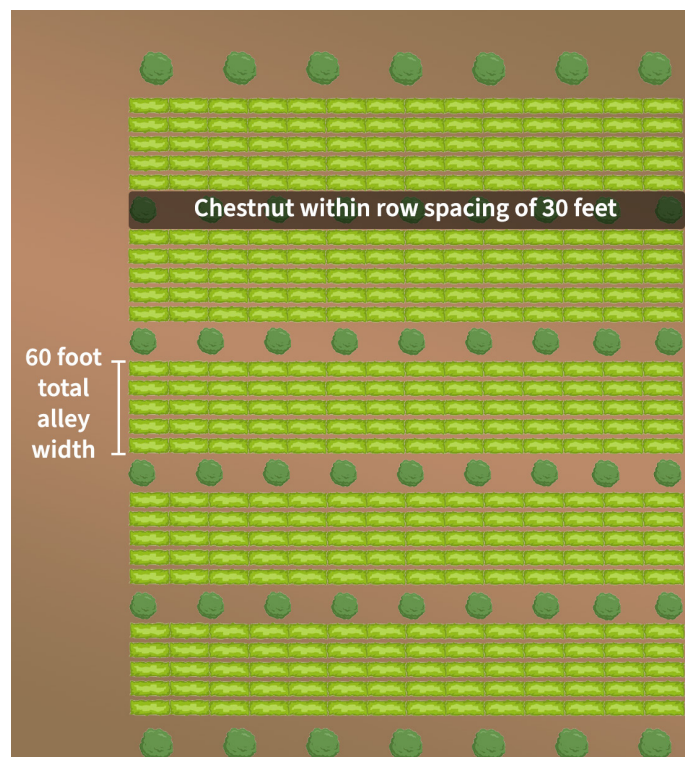
Alley cropping systems change over time. As trees and shrubs grow, they influence the light, water, and nutrient regimes in the field. These interactions are what set alley cropping apart from more common monocropping systems. Management options include changing the crops grown in the alley, root pruning, and using alley cropping as a transitional practice to silvopasture, forest farming, or orcharding. With trees spaced far enough apart, the system can remain static with no alley crop transition needed.



## Project Overview

Appalachian Sustainable Development—in partnership with a network of cross-sector collaborators, including universities (Virginia Tech, University of Virginia's College at Wise, Radford University), government agencies (USDA Forest Service National Agroforestry Center, the Forest Service, Conservation Innovation Grant) and other non-profit organizations (Rural Action, United Plant Savers)—was awarded an NRCS Conservation Innovation Grant titled, *Increasing Landscape-Scale Adoption of Agroforestry Systems in Central Appalachia through Market-Based Incentives*. The purpose of this project was to create a transferable economic incentives system that can be used to encourage forest farming and alley cropping adoption among NRCS Environmental Quality Incentives Program (EQIP)-eligible landowners.

This publication features two farmers, Sarah Barney and Badger Johnson, who established alley cropping demonstration sites as a part of this Conservation Innovation Grant project. Interviews with these farmers help shed light on alley cropping design, management, finance, marketing, lessons learned, and advice for other farmers considering adoption or natural resource providers providing technical assistance to landowners.



Sarah Barney (left) and Badger Johnson (right) have different layouts for their alley cropping systems, showing that different approaches can be successful. USDA Forest Service Graphic by Josh Bundy.

# Case Study 1: Sarah Barney, Among the Oaks Herb Farm

## Farm Details

Among the Oaks Herb Farm is located in Beattyville, Kentucky. It was founded by Sarah Barney in spring 2020, with 1 acre total production and half an acre alley cropped.

## Farm(er) Background

As an ecologist, Sarah has worked on farms since 2012 in a research capacity. After seeing agroforestry practiced on farms in other countries, she was eager to transfer it back home to be a good steward of the land. Alley cropping inspired her to start her own farm business in spring 2019 to produce profitable herbs in a way that is regenerative.

## Crop Details

In Sarah's half acre alley cropping system, she is growing the following species:

- Tree and shrub rows: elderberry, rose, red raspberry, hawthorn, linden.
- Perennial herb alleyways: lemon balm, peppermint, nettle, catnip, anise hyssop, marshmallow, St. John's wort, echinacea, wormwood, elecampane, blue vervain, yarrow.

The trees and shrubs are attracting more birds to her farm, especially insectivores like bluebirds and phoebes, which help combat insect pressure. The elderberry, rose, and red raspberry are all very fast growing with harvests by year 3. The leafy perennial herbs, like mints, nettles, and lemon balm, are fast growing with multiple cuttings throughout the season, making them the most profitable herbs to grow.

## Design

Sarah's alley cropping system was designed with two 4-foot-wide beds in each alley between the woody rows, and a trench dug in-between each alley to help with water catchment and drainage in the floodplain. Red clover was added to the pathways between the alleys and woody rows as a nitrogen-fixing living mulch to suppress weeds and maintain ground cover. Initially, the pathways were spaced to fit a walk-behind mower, but after upgrading to a riding mower, the original spacing no longer works. It's important to make sure the design will fit the equipment



Sarah Barney, owner and operator of Among the Oaks Herb Farm, harvesting catnip in an alley cropping system. Courtesy photo by Seriously Sabrina Photography.

being used, including room for upgrades to larger equipment over time.

## Management

To establish her plots, Sarah mowed and tarped the planting area to solarize and kill the weed competition, tilled the beds for planting, and sowed red clover in the pathways as a living mulch. The pathways are mowed and weed whacked to prevent weeds, like Johnson grass, from creeping into the alleys and to prevent herbs like mint from spreading outside of their beds. Sarah recommends setting up an irrigation system at the outset to help establish and maintain trees, shrubs, and herbaceous crops. Although irrigation systems are a significant investment, hand-watering is difficult, unreliable, and has high labor costs.



Sarah also recommends mulching the entire row of trees and shrubs on top of cardboard, instead of just mulching around each individual plant, to more effectively combat weed pressure throughout the row. For perennial herbs, she recommends deep compost mulch to suppress weed competition. Lastly, Sarah used cages and netting on the trees and shrubs to deter deer.

### Economic Considerations

Sarah has found both economic benefits and challenges from her alley cropping system. There are not many farmers producing crops from trees and shrubs in Beattyville, Kentucky, so Sarah can set the market price without much competition and fill a supply gap for customers who also buy other products she carries. Sarah's customers are interested in how she grows her herbs, and her regenerative agriculture story adds value to her products. Alley cropping has also helped diversify her crops and income streams to mitigate the risks associated with crop failure, market fluctuations, and more.

When Sarah's farm experienced a severe flood, Sarah's alley cropping systems were more resilient than her annual beds. Alley cropping can help ensure a farm's economic viability in the context of extreme weather events.

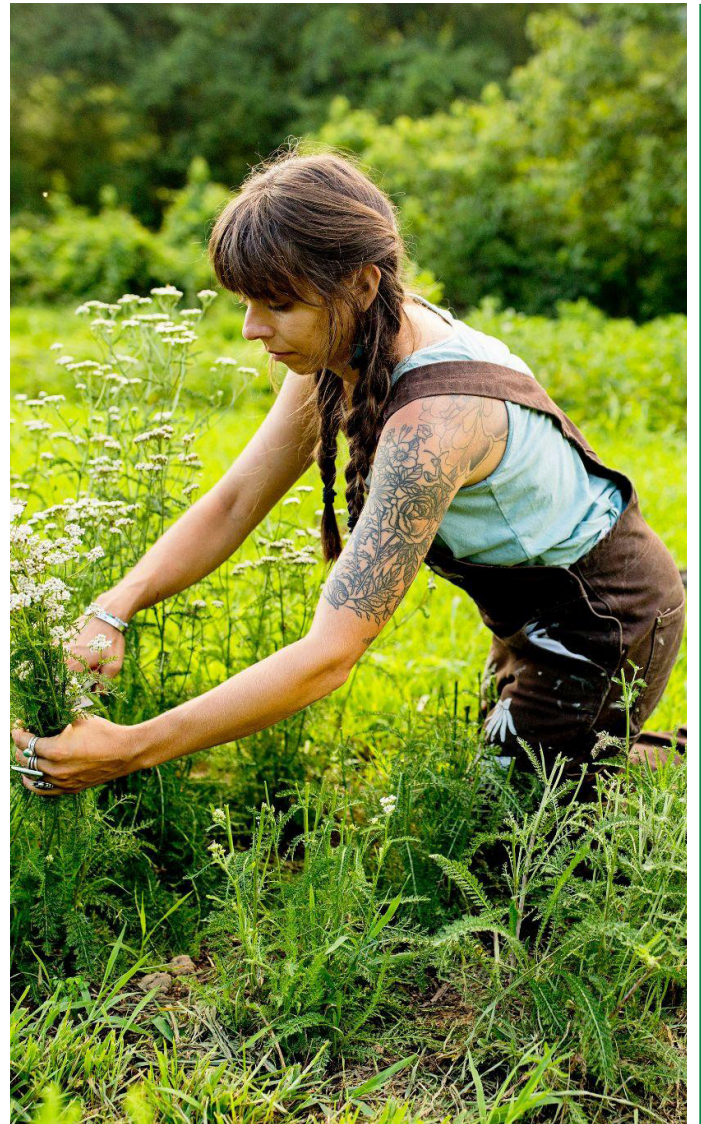
**"I don't think I lost any plants in that flood. When I went back to look at everything . . . everything was held intact better, especially around the trees and shrubs. The beds that had the herbaceous perennial herbs seemed like they held everything together more than the annual beds. That experience has inspired me to do even more alley cropping."**

**~ Sarah Barney**

On the flipside, there are economic challenges to consider with alley cropping. Sarah's most expensive cost on the farm is hand weeding, weed whacking, and mowing her no-till alley cropping system. Sarah recognizes that alley cropping may not be the best fit for a small farm looking to maximize income in the short term because tree and shrub crops take up space and have a longer return on investment. Producing fast growing herbaceous herbs in the alleys, however, provides immediate income while the tree and shrub crops are maturing. Actively tending to herbaceous herbs in the alleys also helps Sarah engage with and tend to her tree and shrub crops more often, compared to planting them out of sight in a separate field.

### Markets

Sarah's herb business has two market segments: 1) value-added products sold direct to consumer via her online store and herbal products CSA, and 2) bulk fresh and dried herbs sold to herbalists and herbal product makers largely outside of the region. So far, the most profitable crops from her alley cropping system are leafy herbs that have multiple cuttings annually, like lemon balm, catnip, and stinging nettle. In terms of shrub crops, rose petals add a lot of value to tea blends, but not as a standalone product, and elderberry is expected to be quite profitable starting in the third year given the sizable growing demand. The least profitable crops are St. John's Wort, elecampane, blue vervain, and bee balm, because these specialty herbs have lower yields and less demand.



Sarah Barney, owner and operator of Among the Oaks Herb Farm, harvesting yarrow for market. Courtesy photo by Seriously Sabrina Photography.



## Support

As a first generation farmer, Sarah did not have upfront capital available for alley cropping and relied heavily on financial assistance from this NRCS Conservation Innovation Grant project to offset costs. Financial assistance from cost-share programs, like NRCS's EQIP, can play a big role in supporting alley cropping establishment and adoption.

## Future Plans and Advice

Sarah is grateful for her alley cropping planting. As a farmer, significant time is spent in the field. It's beneficial to work in a system with elements

of diversity that feel more natural, interesting, and beautiful. In retrospect, Sarah wishes she had invested in and set up an irrigation system and used more mulch in the tree and shrubs rows at the outset of her planting to help cut back on labor costs over time. Before embarking on an alley cropping journey, Sarah encourages farmers to: 1) be genuine and thoughtful in your business development with a focus on profitability; 2) have a well-researched plan for management several years into the future, not just establishment in the first year; 3) use observation, intuition, and adaptation to solve problems; and 4) find solutions that work best for you and your land.



Sarah Barney walking through her newly established alley cropping system. Young trees have been planted in rows. Courtesy photo by Seriously Sabrina Photography.

## Case Study 2: Badger Johnson, Southern Ohio Chestnut Company Home Farm

### Farm Details

The Southern Ohio Chestnut Company Home Farm is located in New Marshfield, Ohio, and has been in operation for two years. The farm has 25 acres in production with 1.25 acres in alley cropping production. Cattle were raised on the farm before it was converted to a chestnut orchard.

### Farm(er) Background

Badger has been farming for four years and decided to integrate alley cropping to produce income before his chestnuts come into their productive years.

### Crop Details

Badger is growing Chinese chestnuts, cut flowers (including cotton, celosia, and cosmos), seed garlic, pawpaws, black locust, and elderberry. He uses buckwheat and white clover as cover crops.

### Design

Within this system, chestnuts are the overstory, pawpaws are the mid-story, and the seed garlic and cut flowers function as a groundcover. The tree crops have their own business plan, and the crops grown in the alleys provide additional income on top of that. Chestnuts are the key species in the system.



Black locust trees are being grown with the chestnuts in the alley cropping system and will be harvested to build a fence around the chestnuts when they begin to produce around year 10. All trees are on drip irrigation. By the end of 2022, the farm will have 2,000 trees in the ground. Badger cover cropped with white clover to fix nitrogen and improve site quality for the garlic plantings. He used round bales of hay as mulch over the garlic, which successfully suppressed weeds.

The Chinese chestnuts were established first and are doing well. The pawpaws were planted more recently and are going through an initial year of shock, which is typical for pawpaws. In time, they will recover and produce.

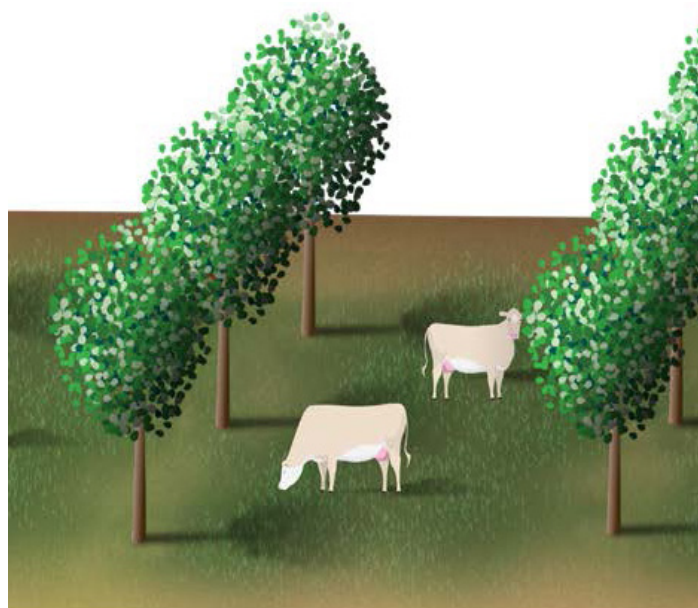
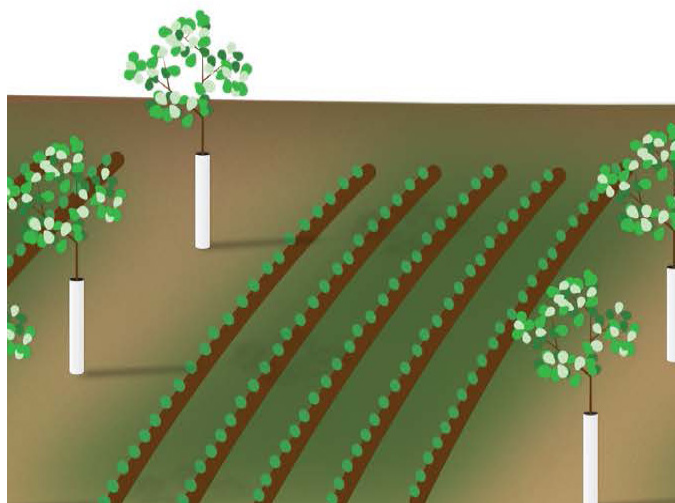
Badger says timing and planning is everything. He is only focused on using plants in his alley cropping system that go through their main stage of growth before the chestnuts leaf out. However, if the Chinese chestnuts begin to produce too much shade for certain crops, he may have to switch to a white clover and timothy grass mix, which makes high quality, sought after hay and tolerates shade and acidic soil.

Badger is also interested in incorporating silvopasture into his alley cropping system in the future. With silvopasture, people often start out as livestock farmers, adding trees to their system to benefit



Badger Johnson and his garlic planting. Courtesy photo by Andrea Miller, Rural Action.

their primary crops, which are livestock. However, Badger's primary crop is the chestnuts, and he is always looking for ways to add value to this crop.



Alley cropping systems over time. When trees are younger, crops are grown between the tree rows. As trees grow and the alleys are more shaded, they can be used for growing forage or silvopasturing. USDA National Agroforestry Center Graphic.



## Management Techniques

In order to establish his alley cropping site, Badger says that brush hogging down to the ground and using three tillage events to disrupt perennial sod worked well. After tillage, Badger found that a buckwheat cover crop was easy to manage and suppressed weeds across the entire area. Irrigation ended up being more of a challenge than he thought it would be. Badger uses drip irrigation for the trees. Mulching eliminated the need to irrigate the garlic. Cotton and garlic have been disease-free. Pests and diseases are controlled by intercropping clover, turnips, and rye for two years and not planting garlic in the same spot for two years. Badger also intercrops other crops to build soil between garlic plantings.

Tall fescue was a dominant species before the alley cropping was established. It can cause problems for cattle and is allelopathic toward some trees and shrubs. Managing for crop production also serves the purpose of controlling undesirable invasive species.

## Economic Considerations

Badger is growing specialty crops, which tend to be more expensive than conventional crops. Badger spent \$1,500 on cotton seeds, \$3,000 on seed garlic, \$100 in spoiled hay, and around \$20 in clover seed. Seed garlic, site preparation, and cover crops have been his biggest expenses. The most labor intensive and time consuming part of Badger's alley cropping

system is harvesting and cleaning garlic. Additionally, as with most farmers, Badger does not pay himself. The annual returns on his alley crops make it easier to wait for the longer term returns from his chestnuts, pawpaws, and elderberries.

## Markets

Badger is hoping to sell his products at various farmer's markets throughout the Midwest. He believes that his most profitable crop will be garlic because the price of seed garlic went up from \$22 to \$30 a pound in recent years. Badger believes that this drastic price increase will be beneficial for his business. When his chestnuts reach reproductive stage, they will be quite profitable as well.

## Support and Training

Badger found attending a training on soil building and weed suppression with cover crops particularly helpful in developing his alley cropping plan. Badger indicated that he would not have been able to plant cotton, celosia, or cosmos without the cost share funding provided by the Conservation Innovation Grant.

## Future Plans and Advice

Badger's advice is to find a profitable niche, and do it on a small enough scale so you can make due with the resources you already have. If you're a beginning chestnut farmer, Badger highly recommends seeking



Garlic planted between rows of chestnuts. Courtesy photo by LaRanda Piatt, Rural Action.



**“One of the dominant species that was present before the alley cropping was tall fescue, which is allelopathic and harms trees. Fill that niche and space with something else that is compatible. What we’re managing for crop production is also serving the purpose of controlling undesirable invasive species. We’re basically stacking functions.”**

**~ Badger Johnson**

profit from alley cropping. The most rewarding thing so far for Badger is replacing smooth brome, thistle, and autumn olive with agronomic crops. The turf grass in the orchard is strongly competitive with the trees for water, nutrients, and growing space. Alley cropping replaces most of the grass and replaces it with white clover and annual crops, which do not

compete as much with the trees for water in the summer. It is better for the trees to grow with garlic and white clover than smooth brome and autumn olive. As far as future plans, Badger is planning to apply for a grant that will help to support the purchase of a garlic planter for his tractor.

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## Conclusion

Alley cropping offers opportunities for producers to achieve their conservation and production goals. The practice can help producers reduce surface water runoff and erosion, improve soil health, and increase crop diversity, along with other conservation purposes. By growing multiple crops on the same unit of land, producers can also increase their income and

reduce economic risks. Alley cropping can be a key practice for climate adaptation through diversification and resilience to extreme weather events. By adding more trees and other perennials to the landscape, alley cropping also presents opportunities for climate mitigation. While alley cropping involves tradeoffs, many producers find it a good fit for their operation.

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## Additional Information

[Working Trees Information Sheet: What is alley cropping?](#)

[Agroforestry Note #12: Alley Cropping: An Agroforestry Practice](#)

[Working Trees Information Sheet: Can alley cropping support soil health?](#)

[Working Trees Information Sheet: Can alley cropping provide more farming options?](#)

[The Agroforestry Handbook: Agroforestry for the UK \(Raskin and Osborn 2019\)](#)

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## Conservation Innovation Grant Information

This publication was developed in cooperation with Appalachian Sustainable Development and Rural Action as part of NRCS Conservation Innovation Grant (agreement #NR203A750013G005) titled *Increasing Landscape-Scale Adoption of Agroforestry Systems in Central Appalachia through Market-Based Incentives*.

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