

Berry College Longleaf Pine Seed Orchard Proposal April 2024

Berry College and the Berry College Longleaf Pine project:

With ~27,000 acres (about 20,000 of those forested), Berry College (Mount Berry, GA) is known as the world's largest college campus. Much of the campus is available for various recreational activities while maintaining important programs in commercial forestry and agriculture (see <https://www.berry.edu/about/campus>) as well as a large Wildlife Management Area and Refuge (w/GA-DNR). The Berry College Longleaf Pine project (www.berrylongleaf.com) was established by Dr. Martin Cipollini and students in the early 2000s with a three pronged focus: 1) to restore existing old growth Longleaf pine (LLP) stands, 2) to establish newly planted LLP stands in Southern Pine Beetle mitigation clearcuts, and 3) to establish seed orchards to address deficiencies in mountain LLP seed sources. Along the way the project has engaged in volunteerism, public education and outreach (all ages), college student training (including prescribed burning), and research (bibliography attached). The project is a prime example of Berry College's mission to "provide an integrated education of the head, heart and hands". In this case, it is an integration of education and outreach (head), conservation (heart), and management (hands). By intimately involving Berry College students in this grant request, we hope to continue this tradition.

Mountain Longleaf pine seed orchard overview:

Heeding a call from several early Longleaf Alliance Mountain LLP conferences, Berry College faculty, staff, and students began establishing seed orchards using mountain LLP stock in the mid-2000s. Most of the trees established have come from old growth stands on Berry College's own campus. As of this date, three seed orchards have been established (one grafted and two seedling-based) for a total of 18.5 acres and over 2000 trees (Table 1). All trees in all orchards are tagged individually with metal tags and the provenance (maternal tree) of each tree is known except for some of "mixed" parentage. Seed sources for mountain (montane) LLP are particularly scarce; seeds are primarily collected from just one location in the Talladega National Forest. In addition to our seed orchards, the Georgia Forestry Commission has initiated a seed orchard using stock from the southern part of the mountain longleaf range (our sources represent the northern part).

- 1) **Grafted Seed Orchard (Baseball Stadium; Figure 1):** At this point, only the smallest (94 tree) grafted orchard has produced what might be considered a commercial crop. About 50 bushels (100 bags) of cones were collected and transferred to Southern Seed Company in 2020, fulfilling a contract that helped initiate this orchard. This orchard has become a silvopasture (sheep) project in collaboration with Berry College's Agriculture Department. An April 2024 survey showed that only a few trees had cones for 2024, but a number had conelets that should develop in 2025. We plan to fertilize all trees and a small harvest will be planned for this orchard in Fall 2024. This will give students an opportunity to learn how to time and conduct a harvest, to prepare and test seed batches, and to establish SOPs and video documentation of procedures.

- 2) **Seedling-based Seed Orchard 1 (Stretch Road; Figure 2):** The second orchard, initiated in 2007, is seedling-based and has some of its +/-525 trees starting to produce cones. This site has been fertilized and burned once, but otherwise has been maintained by mowing and herbicide use within the tree rows after seedlings were established. No trees have yet been mature enough to produce a significant number of cones during a cone-crop year. With proper maintenance, we anticipate that this orchard will come into production with the next major cone crop (trees there averaged 8 inches in DBH in fall 2023). An April 2024 survey showed no trees with significant numbers of cones for 2024 or conelets for 2025. For context, fall of 2023 seemed to be a mast year for cone production in our area. So, we do not expect the next major cone crop for a few years.
- 3) **Seedling-based Seed Orchard 2 (Central Grove; Figure 3):** The third and largest orchard was established starting in 2018 with assistance from The Nature Conservancy and Georgia Pacific funds. This orchard is also seedling-based and has trees ranging from the grass stage to about 10 ft tall. Plans are for the General Ecology class of fall 2024 to conduct a full census of this orchard following some of the maintenance activities planned in this grant request. After site prep herbicide application and Rx burning, the Central Grove site has been subjected to three rounds of herbicide release, two rounds of pre-commercial thinning (PCT directed toward encroaching loblollies), and one round of fertilization. We have not yet been able to burn this site post-planting and we are now past the window of opportunity this spring. As a result of the last round of PCT and herbicide release in the summer/fall of 2023, substantial slash remains on the ground. To bring this orchard up to its full capacity (1560 trees), we would like to mulch and burn it, herbicide planting spots, raise and plant +/- 320 missing trees, and fertilize all trees.

Activities requiring support (Table 2):

- 1) The only routine maintenance that will be necessary for the Baseball Stadium orchard is to fertilize all trees and to repair/expand protective guards that thwart sheep damage. Fertilization for this and the other sites will use approximately 0.5 lbs of Super Triple Phosphate per tree. This is in accordance with previous US Forest Service guidance for the low P soils at these sites.
- 2) For the Stretch Road orchard, we would like to establish a perimeter firebreak (none currently exists) to help avoid wildfire issues in the orchard itself and to reestablish an existing firebreak around the adjacent biodiverse calcareous flatwoods area. When conditions are right, we would like to burn the orchard site itself to help control buildup of litter and duff around trees and to release nutrients. Including the perimeter area and the orchard itself, the total to be Rx burned will be a ~180 acre burn unit. Following burning, we plan to fertilize all trees and to continue to mow as has been done previously.
- 3) For the Central Grove orchard, we plan to use a local contractor to mulch the entire area. This mulching will help distribute fuels more evenly for Rx burning, facilitate site access and possible future mowing and harvest activities, and facilitate planting to fill in spots that are currently missing trees. Following mulching, we would like to prepare fire breaks and Rx burn the site in fall 2024 – using the same contractor. The area to be prepped and burned comprises a 40 acre burn unit including surrounding loblolly stands. Berry

College source (+/- other mountain LLP sources) LLP seedlings will be grown and planted by Berry College students to fill in the missing spots. We are starting these seedlings this spring, so they will be ready for a Fall 2024 or Spring 2025 planting. Following planting, all spots will be fertilized.

Partners and contractors:

- 1) **Berry College Students:** The primary form of support for orchard work has come from the Berry College Lifeworks (student work program). This guaranteed student work program provides work and learn opportunities for all students, up to 16 hrs per week during the school year and up to 40 hrs per week in the summer. Students assist with all aspects of all activities other than bulldozer and chainsaw work. Student wages are included in this grant as in-kind matching funds.
- 2) **Berry College Forestry and Land Resources:** This department helps arrange contracts and partnerships, supports site prep, planting and prescribed burning, and helps educate students who interact with staff members (particularly our Forester Tim Chesnut).
- 3) **Georgia Pacific:** Via Bobby Maddrey, \$3000 per year has been donated specifically for assistance with our seed orchard work. We expect this partnership to continue in future years and can allocate the full \$3000 to this grant as matching funds.
- 4) **Pirelli North America:** Via Maureen Kline, \$10,000 per year has been donated in general support of mountain longleaf pine restoration on the Berry College campus. Much of this has been allocated to support fire break work and prescribed burning. We also expect this partnership to continue in future years and can allocate a portion of this year's funds to this grant proposal as matching funds.
- 5) **The Nature Conservancy (in-kind).** Via Katie Owens, support has been provided for approximately 500 acres of new longleaf pine establishment per year for the past three years. We expect this to continue for at least a few more years. Support has paid for seedling purchase, planting, and prescribed fire assistance on newly established longleaf pine acreages (not orchard sites). TNC did, however, provide \$20,000 that helped establish the Central Grove LLP seed orchard in 2018.
- 6) **Lavender Mountain Earthworks (LME; Lane Redding):** Berry College's Land Resources Department has recently established a contractual relationship with LME to assist with fire break (bulldozer \$180 per hour) Rx burning (\$1200 per day) and other forestry services. While LME charges a bit higher than some other local vendors, they have done very careful and excellent work - especially in environmentally sensitive areas of the campus.
- 7) **Daniel Dunagan, Inc.** This is another local contract who has equipment especially adapted to mulching large areas. This would be the first time working with this contractor. His rate is \$475 per hour using a heavy duty mulcher.
- 8) **Jeff Ward Farms:** For many years, Jeff has been contracted to mow/brushhog on the Berry College campus, including the 5.5 acre Stretch Road orchard. Jeff has given us an estimate for each mowing.
- 9) **Georgia Forestry Commission and Georgia Department of Natural Resources:** Both of these state agencies have contributed in various ways to the longleaf pine project on

campus over recent years, mostly via support for prescribed burning. To date, these partners have not assisted with longleaf pine seed orchard work but the possibility of engaging with them remains open. GA-DNR helps manage our WMA, but much of its focus is on game management.

- 10) **Tall Timbers, Inc.:** Recently, Tall Timbers has collaborated with Berry College in the establishment of S130/S190/L180 fire training certificate program at the college. By the end of 2024, about 65 newly trained faculty, staff, students, and private citizens will receive this certification. Students will be available to assist with Rx burns.

Anticipated outcomes of this grant:

While we currently cannot anticipate a commercial harvest by the end of 2025, the result of this grant should place all three longleaf pine seed orchards in top condition and with full capacity for future cone production. When an adequate cone crop is anticipated, it is our intention to work primarily with a seed company (starting with Southern Seed) to harvest the cones. For the first major harvest, Berry students collected from our grafted seed orchard using orchard ladders and pruning poles. We temporarily stored the cones in our research greenhouse (empty, warm and dry at the time). Kirk Hinson of Southern Seed picked them up for processing. We can handle small numbers of trees in this way, and have facilities and equipment to dry, extract, de-wing, remove chaff, cold store, and test small batches of seeds. We do not have the capacity to harvest everything that we might anticipate in the future, hence the desire to continue to work with an outside contractor when the time comes.

That said, to better assure that the full cone crop is collected safely and at peak condition, we plan to establish a Berry College Student Enterprise (<https://www.berry.edu/studententerprises/>). The enterprise would train students on how to predict a cone crop, know when to collect cones at peak ripeness, how to collect them safely using a bucket lift, how to properly store cones for pickup, and how to get them to the market. Students would also learn how to assess seed crops for viability and to establish standard operating procedures. The intention will be to ultimately have contractors do most of the work with students assisting. Having a towable bucket lift would allow students and faculty to assist with cone collection and better assure that cones would be collected on time (trees are not all on the same schedule, and scheduling a harvesting contractor can be very difficult during large cone crop years). A bucket truck would also make for safer cone collection by students (as opposed to using orchard ladders) and it is ideal that students are trained on the same model that they will use (rental units vary and can be difficult to rent locally). In off years and other down times, there are multiple ways that we could make use of a towable bucket lift on campus. Most importantly, this equipment would be extremely helpful to our American chestnut restoration project, for use in pollinating and harvesting orchard trees on and off campus.

If our greenhouse is not available for cone storage, we have access to a large barn (Emory Barn) where large numbers of cones could be temporarily held in dry ambient conditions.

Short Biography, Dr. Martin Cipollini:

Dr. Martin L. Cipollini is Dana Professor of Biology at Berry College, Georgia, where he teaches undergraduate courses such as General Ecology, Forest Ecology, Field Botany, and Tropical Ecology (Costa Rica/Cuba). He received B.S. and M.S. degrees in Biology from Indiana University of Pennsylvania, and a PhD. in Ecology from Rutgers University. A faculty member at Berry College since 1995, his current research activities revolve around the college's Longleaf Pine and American Chestnut projects. He annually leads large groups of students in service-learning projects on and off campus and has helped direct the blight-resistance breeding program for the Georgia chapter of TACF since its inception in 2006. He has helped establish numerous chestnut orchards across Georgia, including the backcross orchard at Berry College, which was the first such orchard to be established in the state. Since 2002, he has directed the Berry College Longleaf Pine Project and works with the Talladega/Mountain Longleaf Pine Conservation Partnership on projects geared toward regional restoration of montane longleaf pine habitats. He has authored over 50 peer-reviewed papers and ~150 professional presentations in addition to giving numerous public talks, field tours, and workshops.



Figure 1. Berry College Grafted Seed Orchard (Baseball Stadium), April 2024.



Figure 3. Berry College Seedling-based Seed Orchard 1 (Stretch Road), April 2024.



Figure 3. Berry College Seedling-based Seed Orchard 2 (Central Grove). Upper panel before Fall 2023 herbicide application. Lower panel after Fall 2023 herbicide application. Drone photo by Tim Chesnut.

Table 1. Berry College Mountain Longleaf Pine seed orchards and summary of work needed in each.

Orchard name	Baseball Stadium	Stretch Road	Central Grove
Type	Grafted	Seedling-based	Seedling-based
Acres	2.5	5	11
Year trees first planted	2005	2007	2018
Maximum tree number	100	528	1560
Number of living trees	94	526	1241
Number of genetic sources	21	54	49
Source provenances	Mostly Berry College; some Carroll County	Mostly Berry College; some AL and Carroll County	Berry College, Talladega National Forest, Mountain Longleaf Pine NWR, Paulding/Sheffield WMAs
Production year(s)	2020	none yet	none yet
Fertilization needed?	Yes	Yes	Yes
Fire break needed?	No	Yes	Yes
Rx burn needed?	No	Yes	Yes
Mulching needed?	No	No	Yes
Mowing needed?	No	Yes	No
Replanting needed?	No	No	Yes
Notes	Sylvipasture project (sheep); a few non-grafted trees exist in orchard.	Actually more than 54 genetic sources, since Berry College "mixed" genotypes have been added throughout the orchard as replacements. Embedded within calcareous flatwoods community.	Actually more than 49 genetic sources, since Berry College "mixed" genotypes have been added throughout the orchard as replacements.

Table 2. Activities requiring support over the next academic year (2024 through 2025)

Activity						
Mulching	Acres	Details	Cost	Source		Notes and justification:
	11	11 hrs @ \$475/hr	\$5,225	Daniel Dunagan Inc.		Central Grove; needed to clean up and spread out slash from PCT done in 2023. \$475/ hr for 11 hours
Rx burning	Acres	Details	Cost	Source		Notes and justification:
	40	1 day at \$1200	\$1,200	Lavender Mountain Earthworks		Central Grove; includes greater perimeter area (loblolly stands surrounding orchard).
Rx burning	Acres	Details	Cost	Source		Notes and justification:
	180	2 days at \$1200/day	\$2,400	Lavender Mountain Earthworks		Stretch Road; includes greater perimeter area (biodiverse calcareous flatwoods area northeast side of Stretch Road).
Firebreak work	Hours	Details	Cost	Source		Notes and justification:
	8	\$180 per hour	\$1,440	Lavender Mountain Earthworks		Touching up perimeter firebreaks at Central Grove and Stretch Road should take only 1 full day of work.
Mowing	Times	Details	Cost	Source		Notes and justification:
	4	Flat fee	\$1,600	Jeff Ward farms		Stretch Road; needed after burning. \$80/ acre x 5 acers x 4 times

Herbiciding	Spots	Hours	Cost	Source	Notes and justification:
	320	8	\$152	Berry College students	Central Grove; spots for re-planting
Herbiciding	Spots	Sq ft per spot	Cost	Source	Notes and justification:
	320	25	\$70	DMO Herbicides	Central Grove; Glyphosate (2 oz per 1000 sq ft; 8000 sq ft; purchase 1 2.5 gal bottle).
Fertilization	Trees	Hours	Cost	Source	Notes and justification:
	2180	76	\$1,444	Berry College students	All orchard trees; fertilization was last done in 2018
Fertilization	Trees	Lbs	Cost	Source	Notes and justification:
	2180	1090	\$990	Berry Horticulture	Super Triple Phosphate (22 50 lb bags); fertilization was last done in 2018
Growing seedlings	Trees	Hours	Cost	Source	Notes and justification:
	1000	150	\$2,850	Berry College Students	320 needed; Need to plant more than needed in order to assure good seedlings for planting.
Growing seedlings	Trees	Trays needed	Cost	Source	Notes and justification:

	1000	8	\$351	Stuewe & Sons	FT128 – 128 CAVITY 6" DEEP FORESTRY TRAY, including shipping
Growing seedlings	Trees	Media volume (cu. ft.)	Cost	Source	Notes and justification:
	1000	2.5	\$20	Home Depot or Lowes	Sphagnum for Sphagnum + Coarse Vermiculite 1:1
Growing seedlings	Trees	Media volume (cu. ft.)	Cost	Source	Notes and justification:
	1000	2.5	\$150	U-line	Coarse Vermiculite: for Sphagnum + Coarse Vermiculite 1:1, including shipping
Growing seedlings	Trees	Oz needed	Cost	Source	Notes and justification:
	1000	15	\$30	Home Depot	Osmocote + Micros; 1 bag
Planting seedlings	Trees	Hours	Cost	Source	Notes and justification:
	320	6	\$114	Berry College Students	Equipment is available to do planting
Pruning Supplies	Acres	Details	Cost	Source	Notes and justification:
	~180 acres	miscellaneous supplies	\$1,000	Home Depot, online vendors, etc.	General supplies for pruning (orchard ladder, pruning poles, collection bags, safety harnesses, etc.)
Harvesting cones	Item		Cost	Source	Notes and justification:

Used:
<https://www.aerialtitans.com/products/2016-jlg-t350-28>

Towable bucket lift \$19,950 Aerial Titans

Supervising students

Item

Cost

Notes and justification:

Summer stipend

\$6,516

Dr. Martin Cipollini;
 Equivalent to two weeks of full time summer salary.
(0.5 summer mo.x \$11,957/mo.)+0.09% fringe

Indirect Expenses

\$3,494

(10%) of MTDC (\$34,677)

Cost sharing:

2 students X 10 hrs per week X \$9.50 per hour X 24 weeks

\$4,560

GA Pacific annual donation

\$3,000

Pirelli annual donation (30%)

\$3,000

Total matching:

\$10,560

27.5% Percent matching

Student wages for censusing trees, planting and maintaining nursery seedlings, help with Rx burns, fertilizing trees, planting seedlings. etc. applied towards purchase of bucket lift

Total request from TLA

\$38,436

Total budget

\$48,996

Berry College Longleaf Pine Project Bibliography (student authors underlined):

Peer-reviewed research papers:

- Wingo, M.D., A. Rose, T. Chesnut, and M. Cipollini. 2023. Evaluating the efficacy of protective devices to aid in the direct seeding of Longleaf pine (paper being drafted).
- Cipollini, M.L., P. Felch, N. R. Dingley, and C. Maddox. 2019. Changes in tree canopy, understory vegetation, and fuel composition after 10 years of restoration management in an old-growth mountain longleaf pine forest. *Natural Areas Journal* 39(2):197-211.
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Professional presentations:

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- Wingo, M.D., A. Rose, T. Chesnut, and M. Cipollini. 2023. Evaluating the efficacy of protective devices to aid in the direct seeding of Longleaf pine. Symposium on Student Scholarship, Berry College, Mount Berry, GA. April 11, 2023 (M.D. Wingo and A. Rose presenting).
- Cipollini, M.L. 2022. Restoration of old growth montane Longleaf pine forest at Berry College - progress and challenges. *Trees Atlanta: Speaker Series*. Atlanta, GA. September 8, 2022.
- Cipollini, M.L. 2020. Changes in tree canopy, understory vegetation, and fuel composition after 10 years of restoration management in an old-growth mountain longleaf pine forest. North Georgia Prescribed Fire Council Meeting. June 4, 2020. By Zoom.
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- Moss, J.P., N. Bailey, N. Wessel, S. Williams, and E. Humphreys. 2018. The Berry College Central Grove Longleaf Pine Seed Orchard. Council for Student Scholarship Symposium, Berry College, Mount Berry, GA. April 10, 2018.
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- Cipollini, M.L. 2016. Restoring the Mountain Longleaf Pine and American Chestnut. Association of Natural Resource Extension Professionals Annual Meeting and Professional Improvement Conference. Berry College, Mount Berry, GA. August 1, 2016.
- Cipollini, M.L. 2016. Berry College Campus Arboretum and E.L.M. Project. Georgia Association of Natural Resource Extension Professionals Annual Meeting and Professional Improvement Conference. Berry College, Mount Berry, GA. August 2, 2016.

- Cipollini, M.L. 2016. Forest restoration and community engagement: Restoration of Mountain Longleaf Pine and American Chestnut forests in Georgia. Georgia Native Plant Society – West Georgia Chapter, Carrollton, GA. June 21, 2016.
- Cipollini, M.L. 2015. Forest restoration and community engagement: Restoration of Mountain Longleaf Pine and American Chestnut forests in Georgia. Rome Federation of Garden Clubs, Rome, GA. November 2, 2015.
- Cipollini, M.L., N. R. Dingley, and P. Felch. 2015. Changes in vegetative structure across the first decade of restoration management in an old growth mountain longleaf pine forest. Ecological Society of America Annual Meeting, August 9-14, 2015, Baltimore, MD.
- Cipollini, M.L., N. R. Dingley, and P. Felch. 2015. Changes in vegetative structure across 10 years of restoration management in an old growth mountain longleaf pine forest. 74th Annual Association of Southeastern Biologists Meeting, April 1-4, 2015, Chattanooga, TN (Cipollini presenting). Also presented at the Berry College Symposium on Student Scholarship, April 14, 2015, Mount Berry, GA (Dingley and Felch presenting).
- Cipollini, M.L., N.R. Dingley, P. Felch, R. Ware, C. Hughes, R. Carleton, K. Richardson, and B. Erb. 2015. The Berry College Arboretum: Initial inventory and short-term plans. 74th Annual Association of Southeastern Biologists Meeting, April 1-4, 2015, Chattanooga, TN. Also presented at the Berry College Symposium on Student Scholarship, April 14, 2015, Mount Berry, GA (Dingley and Felch presenting).
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- Cipollini, M.L. 2014. Forest restoration and student/community engagement. Bonner Summer Leadership Institute: Community-Based Learning: Pedagogies, Partners, and Practice Symposium. May 29, 2014, Berry College, Mount Berry, GA.
- Cipollini, M. L. 2014. Natural forests, native trees and healthy watersheds: Restoration of Mountain Longleaf Pine and American Chestnut Forests in Georgia. Georgia Statewide Arbor Day Celebration, Rome, GA, February 18, 2014.
- Cipollini, M. L. 2012. The Berry College Longleaf Pine Project: Lessons for Marshall Forest. Emma Lewis Lipps Ecology Lecture. Shorter University, April 11, 2012.
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Project description (500 words).

This project seeks to conduct necessary management activities and to establish a student run enterprise designed to bring Berry College's three mountain longleaf pine seed orchards into commercial production. See <https://sites.berry.edu/mcipollini/wp-content/uploads/sites/34/2024/04/Berry-College-Longleaf-Pine-Seed-Orchard-Proposal-April-2024.pdf> for a full project description. The three orchards include a grafted orchard established in 2015, a seedling-based orchard established in 2017, and another seedling-based orchard established in 2018. Scion or seed sources for these orchards are nearly all from northwestern GA mountain longleaf pine sites, mostly from Berry's old growth stands. This is a description of each site and a summary of the work to be done:

- 1) Grafted Seed Orchard (Baseball Stadium): At this point, only this smallest (94 tree) orchard has produced a commercial crop. About 50 bushels (100 bags) of cones were collected and transferred to Southern Seed Company in 2020. An April 2024 survey showed that a few trees had cones for 2024, but a number had conelets that should develop in 2025. We plan to fertilize all trees and a small harvest will be planned for this orchard in Fall 2024. This will give students an opportunity to learn how to time and conduct a harvest, to prepare and test seed batches, and to establish SOPs and document procedures (including video).
- 2) Seedling-based Seed Orchard 1 (Stretch Road): This site has some of its +/-525 trees starting to produce cones. This site has been fertilized and burned once, but otherwise has been maintained by mowing and herbicide use within rows after seedlings were established. No trees have yet produced a significant number of cones. With proper maintenance, we anticipate that this orchard will come into production with the next major cone crop (trees averaged 8 inches in DBH in fall 2023). An April 2024 survey showed no trees with significant numbers of cones for 2024 or conelets for 2025. For context, fall of 2023 was a mast year for cone production in our area. So, we do not expect the next major cone crop for a few years. Plans for this site include firebreak work, mowing, a prescribed burn, and fertilization.
- 3) Seedling-based Seed Orchard 2 (Central Grove): The third orchard was established with assistance from The Nature Conservancy and Georgia Pacific funds. This orchard has trees ranging from 1 to 10 ft tall. Plans are to conduct a full census of this orchard following some of the maintenance activities described below. After site prep herbicide application and Rx burning, the Central Grove site has been subjected to three rounds of herbicide release, two rounds of pre-commercial thinning (PCT directed toward encroaching loblollies), and one round of fertilization. We have not yet been able to burn this site post-planting. As a result of the last round of PCT and herbicide release in the summer/fall of 2023, substantial slash remains on the ground. To bring this orchard up to its full capacity (1560 trees), we would like to mulch and burn it, herbicide planting spots, raise and plant +/- 320 seedlings, and fertilize all trees.

Project goals (500 words)

By the end of spring 2025, we plan to have completed all management work as described above. This work should have all three orchards in ideal condition for future seed production. While we cannot anticipate a commercial harvest by the end of 2025, the result of this grant should place all three longleaf pine seed orchards in top condition and with full capacity for future cone production. When an adequate cone crop is anticipated, it is our intention to work primarily with a seed company (starting with Southern Seed) to harvest the cones. For the first major harvest, Berry students collected from our grafted seed orchard using orchard ladders and pruning poles. We temporarily stored the cones in our research greenhouse (empty, warm and dry at the time). Kirk Hinson of Southern Seed picked them up for

processing. We can handle small numbers of trees in this way, and have facilities and equipment to dry, extract, de-wing, remove chaff, cold store, and test small batches of seeds. We do not have the capacity to harvest everything that we might anticipate in the future, hence the desire to continue to work with an outside contractor when the time comes.

That said, to better assure that the full cone crop is collected safely and at peak condition, we plan to establish a Berry College Student Enterprise (<https://www.berry.edu/studententerprises/>). The enterprise would train students on how to predict a cone crop, know when to collect cones at peak ripeness, how to collect them safely using a bucket lift, how to properly store cones for pickup, and how to get them to the market. This work would be focused on the Grafted Seed Orchard that will have some trees with mature cones in fall 2024. Students would also learn how to assess seed crops for viability and to establish and document standard operating procedures. The intention will be to ultimately have contractors do most of the work with students assisting. Having a towable bucket lift would allow students and faculty to assist with cone collection and better assure that cones would be collected on time (trees are not all on the same schedule, and scheduling a harvesting contractor can be very difficult during large cone crop years). A bucket truck would also make for safer cone collection by students (as opposed to using orchard ladders) and it is ideal that students are trained on the same model that they will use (rental units vary and can be difficult to rent locally). In off years and other down times, there are multiple ways that we could make use of a towable bucket lift on campus. Most importantly, this equipment would be extremely helpful to our American chestnut restoration project, for use in pollinating and harvesting orchard trees on and off campus.

If our greenhouse is not available for temporary cone storage, we have access to a large barn (Emory Barn) where large numbers of cones could be temporarily held in dry ambient conditions.

Current production:

A single harvest of about 50 bushels was harvested so far in 2020 (from our grafted seed orchard). Typical seed production per cone is about 28. At about 65 cones per bushel, that means the first harvest was about 91,000 seeds. This could very well be an overestimate since we did not count the cones.

Future improvements:

We expect to have all three orchards, 18.5 acres, +/- 2180 trees in production within 5-10 years. No commercial harvest is anticipated within the time frame of this grant application. In the long run, if even half of the existing trees produced 0.5 bushel, our estimate of seed production would be 2180 trees X 0.5 X 32 cones per tree X 28 seeds per cone = 976,640 seeds in a mast year.