HTIRC HARDWOOD TREE IMPROVEMENT & REGENERATION CENTER

From the Director's Desk – Fall 2025

As autumn colors begin returning to Indiana's forests, I'd like to take a moment to reflect on the collaborations, research, and engagement activities that continue to advance the mission of the Hardwood Tree Improvement and Regeneration Center (HTIRC). From expanded partnerships to innovative research and hands-on education, our work so far this year underscores a shared commitment to sustaining healthy, diverse, and resilient hardwood forests.

We are delighted to welcome Phil Woolery as our new engagement specialist, supporting the HTIRC, the Indiana Forestry & Woodland Owners Association (IFWOA) and the Walnut Council. Phil has degrees in forestry from Iowa State University (BS) and Purdue University (MS) and brings more than a decade of experience as a Purdue Extension Agriculture and Natural Resources Educator. Phil also has been a certified arborist and FAA-licensed drone pilot. His strong background in forestry and outreach will help strengthen connections among researchers, landowners and forestry professionals statewide.

This summer, HTIRC staff participated in the 2025 Walnut Council annual meeting in Rockford, Illinois, which drew more than 100 forestry professionals from across the country. Field tours and demonstrations explored fine hardwood management, regeneration, and technology applications. Cameron Wingren from Purdue Digital Forestry showcased innovative forest measurement tools, while Lenny Farlee, Liz Jackson and Phil Woolery contributed to hands-on learning sessions and discussions.

In September, HTIRC co-hosted the North Central Forest Pest Workshop with Purdue's Institute for Digital Forestry and the Indiana Department of Natural Resources, highlighting the Application of Digital Technology for Forest Health. The workshop brought together over 70 forest health specialists, researchers and students for field tours and presentations on resistance breeding, oak management and digital forestry.

This summer, we also met with partners from Let the Sun Shine In – Indiana (LSSI) and the White Oak Initiative. Both groups share our goals of sustaining oak-hickory and white oak ecosystems through science-based management, education, and stakeholder engagement—efforts that closely align with HTIRC's mission and values.

Looking ahead, Purdue staff will host the Indiana Woodland Owner Conference on October 31 at the Nelson-Stokes-Lewman Woodland in Putnam County. The event will feature field demonstrations on enrichment plantings, oak regeneration and woodland management strategies, including projects supported by HTIRC funding.

This summer, two new projects were funded as part of our stakeholder-driven funding model. They are as follows:

- Understanding the role of carbohydrate dynamics in white oak regeneration – Morgan Furze, $136,430
- Modeling tree neighborhood interactions and their effects on hardwood growth and regeneration in Indiana forests– Insu Jo, $149,403

On the tree improvement front, Caleb Kell continues to make great progress. I encourage you to read his 2025 Harvest Outlook, which brings encouraging news of early and abundant nut crops, setting the stage for strong seedling availability into the future.

Together, these activities showcase the strength of our partnerships and the growing impact of our applied forestry research and outreach. Thank you for your continued support of HTIRC.

Best,
Matt Ginzel,
Director, HTIRC

Modeling Tree Neighborhood Interactions and Their Effects on Hardwood Growth and Regeneration

Understanding how individual trees interact with their neighbors is essential for developing management prescriptions that support the regeneration and growth of hardwood species.

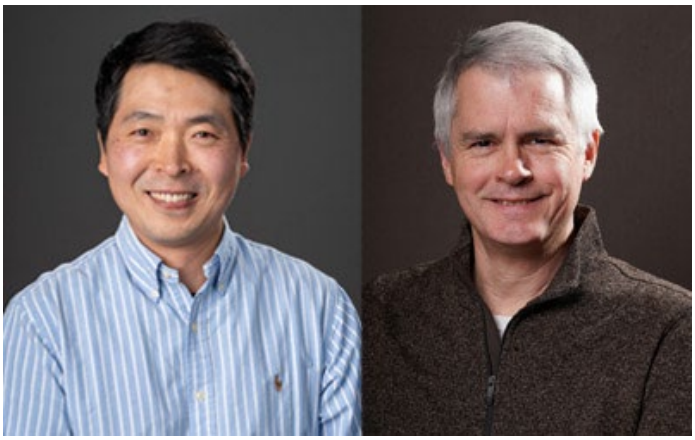
A newly-funded HTIRC research project led by Drs. Insu Jo and Mike Jenkins seeks to analyze data from the Continuous Forest Inventory (CFI) to discover how species interaction, distancing, management techniques and invasive species effect growth and health.

“I am really interested in forest tree dynamics within temperate forests and what are the consequences of those dynamics and processes,” Jo said. “Mixed forests are quite complex and the tree locations are highly variable. We need to know the effects of those different spatial arrangements and other stand-level conditions on tree growth and mortality. By analyzing the standardized inventory measurements over the years with access to accurate plot locations, I think we can identify some key significant variables and mechanisms of species interactions that can help forest managers.”

Jo and Jenkins will work in conjunction with the Indiana Department of Natural Resources, which maintains the CFI data, as well as other partners at Purdue, Indiana University and the United States Forest Service on the project.

The CFI database, which includes more than 8,000 plots across Indiana spanning nearly 800,000 forested acres and more than 300 million trees, is updated every five years, allowing for researchers to track growth and composition over time. Data includes plot level information including total number of trees within the plot, total biomass within the plot and the number of species within the plot, while also documenting locational data. Data also may include information on management history over the cycle of three or four measurements for each plot.

"When data is collected, not only do we know the center position of the plot, but the angle of the specific trees and the distance from the center of the plot, which will allow us to reconstruct all of the individual trees within the plot," Jo explained. "That is the novel area of this research, using the spatial inventory data to bridge the gap between individual tree-level interactions and plot-level ecological processes to understand tree species interaction and the effects on tree performance. We should be able to develop some metric information about how species grow bigger or healthier or have lower mortality with certain species. This can provide guidelines for landowners or managers for how to manage particular species with specific interests in mind."



To begin, Jo will convert the CFI data into an individual tree map based on the field measurements. This will allow it to be utilized in conjunction with LiDAR and high-resolution imagery to match imagery with observations from field foresters.

He will then develop a metric to quantify the impact of neighboring trees on individual growth based on the distance from each individual tree, species competition for light and nutrients and the growth of those trees. This project also will look at how invasive species abundance and soil fertility affect regeneration of tree species and how canopy tree spatial arrangements affect understory invasions.

The CFI database will provide measurements such as tree diameter, species identity and spatial location. Plot level information also includes understory invasive species cover and tree species sapling counts. Soil chemistry data such as pH, organic matter and nutrient concentrations will be integrated through a collaboration with Dr. Richard Phillips at Indiana University.
After the initial mapping, statistical modeling will allow researchers to analyze the impact of different variables on tree growth.

Initially Jo and his collaborators will focus on key economically important species, such as oak, hickory and walnut before expanding their scope. They hope to identify spatial configurations that favor the success of oaks and hickories, while suppressing competition from undesirable vegetation.

The findings of this project should provide advice about management techniques specifically tailored to mixed species hardwood systems in Indiana based on species interaction with neighboring trees and overall overstory spatial structure.

Researchers then hope to expand their analysis outside of Indiana to apply to all hardwood forests in the eastern United States by tapping in the national Forest Inventory and Analysis (FIA) program, which is maintained by the Forest Service.

Meet the P.I. – Dr. Insu Jo

Dr. Insu Jo grew up on Jeju Island, the largest island in South Korea. His parents were farmers, operating a mandarin orange orchard. Insu played around the farm and had a "quite close connection to nature," which eventually led him to study plant ecology at Seoul National University.

Jo completed his bachelor's degree (2007) and remained at his alma mater to work on a master's degree (2009) studying threadleaf water-crowfoot, an endangered aquatic plant species in South Korea, found only in rice paddies.

From there, Jo landed at Syracuse University, where he worked on his PhD under Drs. Jason Fridley and Doug Frank, looking at the impacts of non-native plant invasions in the eastern United States.

"Jason Fridley is a plant community ecologist whose primary research focuses on plant invasions, while Doug Frank is an ecosystems ecologist studying the effects of ungulates on plant-soil feedback in Yellowstone," Jo explained. "I got the benefit of working with both, looking at the invasion impacts on ecosystem processes, particularly nitrogen cycling. I did quite a lot of work collecting plant functional traits and comparing those traits for both leaves and roots and how those differences link

to soil nutrient cycling. I did a lot of decomposition experiments, digging in soil, making monoculture plots and harvesting."

Jo met Dr. Songlin Fei at an Ecological Society of America meeting and came to work with him as a postdoctoral scholar at Purdue from 2016 to 2018. During that time, Jo expanded his knowledge base, transitioning from experimental scientist to data driven modeling, specifically modeling tree dynamics using the Forest Inventory and Analysis Database (FIA).

A forest ecologist position in the Manaaki Whenua Landcare Research Group within New Zealand's Crown Research Institute system (now the New Zealand Institute for Bioeconomy Science Limited) drew Jo back around the globe. While there, he analyzed national forest inventory data to examine plant invasion dynamics, focusing on multi-species impacts and the role of canopy disturbance on understory invasions, as well as tree demographic processes, testing tree recruitment, growth and mortality are shaped by species traits and environmental conditions.

After six years at Manaaki Whenua, Jo saw the opportunity to return to Purdue as a research assistant professor in the Institute for Digital Forestry, reuniting with Dr. Fei to explore how disturbance and climate change influence forest dynamics.

"I liked living in New Zealand, but I felt a bit limited in terms of the research," Jo said. "I thought maybe it was time to development myself more. I saw the opening at the Institute of Digital Forestry and that they were trying to incorporate some high-tech driven data into traditional inventory data analysis. I thought that was an area I could adapt and improve myself for the next stage of my life."

Understanding the Role of Carbohydrate Dynamics on White Oak Regeneration

White oaks are a keystone species in the Central Hardwood Forest Region, for many reasons from aesthetics to cultural, ecological and economic value. White oak is used in a variety of commercial forest products from whiskey barrels to flooring, cabinetry and furniture as well as pulpwood for paper production. The species also has importance for wildlife as both a source of food and shelter.

Despite its widespread range across much of the central and eastern United States and long lifespan (surpassing 200 years), white oak has historically been managed by generalized prescriptions developed on red oaks. This is in part due to the more rapid seedling/sapling aboveground growth of northern red oak compared to white oak, which has made it an easier study subject. White oak will commonly wait several years to start its aboveground growth, instead putting its resources largely into roots, while red oak is more immediate.

A newly-funded HTIRC project, co-led by Drs. Morgan Furze and Mike Saunders, aims to change reduce the knowledge gap surrounding white oaks, specifically looking at the physiology of white oaks and the trees' response to drought and prescribed fire.

"I was drawn to this project because naturally I could see how physiology could help solve this problem of understanding how white oaks

successfully regenerate," Furze said. "Mike Saunders is an expert on white oak regeneration and can speak to people about forest management in a way that I cannot. I can bring the physiology part to it and tell you how the plants work and function in response to their environment. Bringing together the fundamental physiological perspective with someone who has an amazing forest management and applied perspective, we can have a bigger impact with our work.

"White oaks are declining and being replaced by other tree species like maple. In order to have forests that are canopy dominant for white oak, we need to rethink the management practices we are using and that is what we hope our study will provide some insight into. We're hoping that by understanding the physiology of white oaks and how it impacts their ability to regenerate and persist, we will be able to improve white oak management."

The project "Understanding the Role of Carbohydrate Dynamics on White Oak Regeneration" will build upon the master's thesis project of Eli Gafney (2025), which evaluated artificial white oak regeneration along light and competition gradients. Gafney's work studied the response of planted white oak seedlings in an enrichment/underplanting contest. Seedlings were planted under a variety of light and understory competition conditions. In a shade house study, Gafney compared white and northern red oak response to a similar range of light conditions and used honeysuckle as a competitor. This allowed for physiological measurements and more detailed analysis of biomass allocation.

In general, this project will look at how planted (or artificially regenerated) white oak seedlings respond to various stressors.

"My hope is to refine the growing conditions needed for successful artificial regeneration of white oak," Saunders explained. "What management treatments are needed? When are they needed? For how long? And how can we best spend resources to favor white oak."

When a tree photosynthesizes, it makes sugars that it can convert into starch. The sugars and starch can then be used for a number of things from growth to respiration, reproduction and chemical defense production, but they can also be stored away for later use.

"Think of it like an emergency fund," Furze explained "Plants can put away those carbohydrates into their savings bank and when a stressful situation comes along where they can't photosynthesize and make new carbohydrates, they can reach into that savings account and pull out those stored carbohydrates. That will allow them to survive and persist until conditions become favorable again. It is very much analogous to animals storing fat. If you didn't eat lunch for some reason and you have a situation where you need to do something stressful to your body, hopefully you have some fat reserves that can bide you some time until you have a chance to eat your next meal."

So, what can researchers learn from carbohydrates in white oaks?

White oaks once dominated eastern North American forests, but they have been declining over time due to changes in land use as well as changes in the environment. In order to regain canopy dominance, white oak management must prioritize their regeneration. One way that oaks have been found to survive and thrive is through the use of fire.

"White oaks are adapted to rely on fire disturbances to maintain their dominant position in the forest," Furze said. "In many cases they will actually survive, thrive and regenerate better in this environment, as it opens the forest canopy. They have less competition from their neighboring trees and invasive species, creating a very favorable environment for white oak seedlings to establish and grow up. When a white oak gets burned by fire, it resprouts, which means it regrows new shoots from the pre-existing plant. That resprouting process is driven by carbohydrates. We know that the carbohydrates that are stored in the roots are going to help build the body of the new growth, but we really don't have any idea about how white oaks store and use their carbohydrates specifically. We want to know what carbohydrates are doing in white oaks and also how that changes and influences resprouting success as they respond to prescribed fire and drought and other stressors."

The first step in that process is gathering root samples from existing white oak and red oak plots, approximately three years old, to get baseline carbohydrate measurements. Then, these can be compared to show species similarities and/or differences. Root samples are being analyzed for sugar and starch measurements. They will be retested again over time to see how the measurements change naturally when seasons change. Although researchers are taking samples from the roots, it is not enough to damage them. The sample size needed to test carbohydrates in roots is around 10 milligrams of dried and ground tissue, or about the amount of salt you can pinch between two fingers.

Part of the existing red and white oak plot at Richard G. Lugar Forestry Farm, which is being measured for carbohydrates in the roots, also was burned in a top kill fire this past spring to simulate surface fire conditions. The resulting resprouts also will be measured to see their carbohydrate levels following fire.

"As those sprouts become able to photosynthesize and make new carbohydrates, we are curious if the emergency fund in the roots will refill," Furze explained. "We will burn them again eventually and see how many sprouts come up the next time. Will we see a pattern of the trees using up the reserves and then refilling them or with repeated fire will they just deplete their reserves and never replenish them? These results could allow us to determine if carbohydrate reserve levels influence resprouting and sprout success. We are also interested in understanding the timing of burns in relation to other stressors in the environment such as drought."

The second part of the project is taking place in a greenhouse, where some white oak seedlings will first undergo a simulated burn by way of a blowtorch, while others will not be burned. All of the trees will then be placed back in the greenhouse where some trees will receive regular water supply, while others will be placed in simulated drought conditions.

“Our experimental design with some droughted and some not and some treated with fire and some not will give us several combinations. Then, we can tease apart the impacts of drought versus fire or the combined stressors,” Furze shared. “We’re interested in looking at what happens if prescribed burns occur in a drought year. What impact does that have on the capacity to resprout and the success of new resprouts? We are doing burn then drought, but you could also think about it the other way, too. If there has been a drought, should you burn now or give them time to recover before burning.”

While the findings of the experiment are still a few years away, possible outcomes from the project could go a long way toward understanding the resilience of white oaks. Studying carbohydrate dynamics and gaining knowledge about what is going on in the root system of white oaks in general can give researchers a better understanding of the species’ physiology.
This, in turn, will allow for forest managers to make better predictions regarding their resilience in the face of other environmental stressors.

“At the bare minimum, I hope this project will open people’s eyes to the fact that we should potentially reconsider forest management practices to be more species specific and perhaps move away from applying management practices learned from red oak to white oak,” Furze concluded. “An amazing end goal would be if we find something about the timing or frequency of prescribed burns that could change how forests are managed.

“What we are doing now is the first step. Later we can explore this across different aged stands and different environments and in forests with different species composition. There are many biotic and abiotic interactions that will help build a bigger picture over time, but, for now, we will hopefully increase our foundational knowledge about white oak regeneration and how things work.”

Meet the P.I. – Dr. Morgan Furze

Dr. Morgan Furze, assistant professor of botany and plant pathology and forestry and natural resources, considers herself an eco-physiologist. Her work considers how plants function in response to their environment.

Although Morgan's favorite activity as a child was being in the garden club in elementary school, learning about and working with plants, her path to her current position was anything but linear. But, in the end, she returned to her roots to find a promising research and teaching career.

As an undergraduate student in biology at Bucknell University, Furze did undergraduate research in a bat lab, studying white nose syndrome, a fungal pathogen, while earning a bachelor's degree in biology (2012).

"I didn't take any plant science courses at all, which I think is kind of interesting," Furze shared. "I like to tell students that so that they are inspired to change their path as many times as they need to find the right one."

Not only did Furze not study plants, the closest she got to them during that time was a Chinese brush painting class that took place in a greenhouse. "I was observing plants, but I didn't know how they worked at all," she noted.

With many of the people around her moving on to graduate school, Morgan decided to combine her interests as a yoga instructor and in health to work towards a PhD in nutrition. After one semester, she pivoted and took a job working for the National Audubon Society in New York City. There she was part of a community conservation and education team and helped with the production of children's science magazines and scholarships for community conservation programs. She still wasn't thinking about plants, mostly birds. But, as she spent time hiking in nature, she began to be curious about how organisms responded to their varying environments, revisiting lessons from her youth.

"I remember in fourth grade, I first heard the words global warming and teachers were telling me about sea level rise and that it was going to be a threat in the future," Furze recalled. "Early on in my education it was instilled in me that this was something that I should care about. I think that drove me to be more conscious about how I interacted in the environment, like always riding my bike, etc. It always seemed like a pressing issue and as a child I was confused as to why no one was doing anything about it."

When she looked at continuing her graduate studies after leaving the nutrition path, she recalled her early passion for plants and the garden club and thought maybe something related to that could hold her interest.

The program she joined at Harvard University focused on organismic and evolutionary biology. Furze finished her PhD in 2019 with a dissertation on "Understanding whole-plant non-structural carbohydrate storage in a changing world."

"Everyone was doing something ecology or evolution related, but on a specific organism," Furze explained. "I was in a tree lab and I have stuck with it ever since. I did a postdoc where I worked in agro-ecosystems, specifically on almond trees in California, and now I'm still in the tree lab. In my lab, we study trees in all different environments. I am always jumping around doing different things, working in a new system or asking a new question, which is why this is a pretty good job for me.

"I was always interested in the environment and preserving our environment and one way I could think to do that was to study how forests responded to global change. What we do in my lab tends to be very basic or fundamental research where we are looking at the mechanisms that underlie why a tree responds the way it does or how it physiologically works. But, as I have gotten further and further along, I have recognized that doing research that is also applied is really rewarding because you can have tangible impacts and can try to solve a little piece of the puzzle."

Planting Conservation Seedlings – Steps to Success

Success with tree plantings for conservation purposes like wildlife habitat, re-establishing forest areas, controlling erosion, creating windbreaks or riparian buffers, or future timber products involves prior planning and preparation before the first tree is planted. Here are some steps to take to improve your chances of success.

1. **Get Help!** Contact a professional forester for guidance. This could be your state forestry agency or private sector foresters. In Indiana, you may contact the Division of Forestry or use the Find an Indiana Forester website. For other states, contact your state forestry agency.
2. **Make a plan**. The forester can assist you with outlining your goals for the planting, your site conditions and the steps you need to take to select, order, plant and care for the trees.
3. **Select the appropriate species**. Tree and shrub species to plant are selected based on the conditions of your planting site and your objectives for the planting. Soil info can be obtained from the Web Soil Survey.
4. **Design the planting**. Deciding on spacing, species mix, arrangement, access lanes and row orientation are decisions you can make with your forester, based on your objectives.
5. **Prepare the planting site**. Weed competition on the site is easiest to control before planting. Management practices to address soil compaction, pH and soil fertility are also best done prior to planting. Planting a cover crop may also be advantageous for erosion protection or weed suppression. These are all activities that can be done in the late summer or fall before planting.

6. **Obtain quality seedlings**. Tree and shrub seedlings may be available from public and private nurseries. Your forester and the Reforestation, Nurseries and Genetic Resources website can provide referrals to nurseries. For seedlings from the Hardwood Tree Improvement and Regeneration Center you can contact Tree Pro or order from the IDNR State Tree Nurseries (Indiana landowners). Conservation plantings are normally done with bareroot or containerized seedlings ordered in the fall and planted in the spring.
7. **Care for the seedlings**. Keep seedlings cool and moist until planting and plant as soon as possible after pickup or delivery.
8. **Plant the seedlings**. Most bareroot seedlings are planted in spring. Planting at a proper depth and sealing the planting hole to prevent drying out roots improves survival and growth.
9. **Post-planting care**. Weed control near the seedlings and protection from animals like deer or livestock are two important maintenance practices to help seedlings become established.
10. **You might be eligible for a tax break!** If you planted at least one acre for timber production purposes, you may be able to deduct up to $10, 000 of planting expenses on that year's tax return. Find out more at the National Timber Tax website.

Find out more at:
Hardwood Tree Improvement and Regeneration Center Landowner Information
Planting Forest Trees and Shrubs in Indiana
Site Preparation and Competition Control Guidelines for Hardwood Tree Plantings
Reforestation, Nurseries, & Genetics Resources
Contact the USDA Service Center in your area for questions about conservation incentive programs.
Purdue Forestry and Natural Resources Extension

HTIRC Co-Hosts Regional Forest Health Conference

The HTIRC, along with Purdue's Institute for Digital Forestry and the Indiana Department of Natural Resources, hosted the North Central Forest Pest Workshop September 29 – October 2 with the theme of "*Application of Digital Technology for Forest Health*." The event included a day-long field tour of HTIRC and digital forestry research at the Purdue's Richard G. Lugar Forestry Farm and Martell Forest. HTIRC staff Caleb Kell and Dr. Aziz Ebrahimi shared projects on resistance breeding of butternut and chestnut, and Dr. Mike Saunders presented research featuring oak management using prescribed fire and shelterwood treatments.

The meeting format also included state and provincial forest health reports and research presentations. A half day was reserved for presentations about HTIRC research and the latest digital forestry information from the Institute for Digital Forestry.

The North Central Forest Pest Workshop (NCFPW) is an annual gathering of persons interested in forest health issues facing the north central portion of North America. This region encompasses Manitoba and Ontario in Canada; and Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri and Wisconsin in the United States. The 2025 NCFPW attracted 70 plant pathologists, forest entomologists, foresters, researchers, students and more.

Indiana Woodland Owners to Tour Purdue's Nelson-Stokes-Lewman Property

On October 31, Purdue Forestry & Natural Resources forestry staff will be hosting the Indiana Woodland Owner Conference at the department's Nelson-Stokes-Lewman Woodland property in Putnam County.

This morning tour will visit the 162-acre property used for research and demonstration. Purdue foresters will discuss topics such as stiltgrass control, regenerating openings with desirable species, enrichment plantings to encourage more oak, management after a storm damage harvest and management of a mature oak woods.

One of the research projects on the property is aiming to establish Northern red oak, white oak, chinkapin oak and American Chestnut underplantings in forest openings. The HTIRC-funded project titled "Testing Efficacy of Enrichment Plantings for Stand Regeneration in Hardwood Forests" was recently described in the HTIRC 2024 annual report (page 7-8). Learn more about this tour and the conference on the IFWOA website.

HTIRC Mid-Season Breeding Update

by Caleb Kell, HTIRC Operational Tree Breeder

2025 Harvest Outlook
An unusually wet and rainy June and July have transitioned into an extend period of cool, dry weather which has stimulated many nut trees to begin dropping seeds two weeks earlier than usual. Combined with a lack of late spring frosts, crops of walnut and butternut are both heavy and early. Barring nursery issues, those seeking to plant HTIRC select American chestnut, black walnut, butternut and white oak seedlings in 2027 should find them in good supply.

Look for American Chestnuts in October
Going on a hike in southern Indiana this fall? Keep an eye open for American chestnut stump sprouts and seedlings, which turn a brilliant yellow color and have distinctive long, toothed leaves. If you find an American chestnut, report it on the iNaturalist app (or inaturalist.org). Every new American chestnut found and reported in Indiana allows the HTIRC to further diversify and expand its American chestnut restoration program.

Walnut Council Hosted 2025 Annual Meeting in Rockford, Illinois

The 2025 Walnut Council annual meeting took place this past July in Rockford, Illinois., drawing over 100 attendees from around the country. This event featured a diverse program that focused on the management of fine hardwoods.

A highlight of the meeting was a trip to a property in southern Wisconsin that had been donated to the Walnut Council. This property has produced walnut trees of over 30 inches in diameter and includes several walnut plantations. Program topics included crop tree release demonstrations, timber stand improvement and natural regeneration management.

The event also featured a presentation by Cameron Wingren from Purdue's Institute for Digital Forestry, showcasing innovative forest measurement tools and their potential applications for forest management. Other HTIRC staff that assisted in the event were Lenny Farlee, Liz Jackson and Phil Woolery.

Participants left with practical knowledge and skills to improve their forest management, including tree planting, invasive species control and thinning. that would enable them to implement practices like tree planting, invasive species management and thinning on their properties.