April 2021

Missouri Chapter News

Walnut Council: Growing Walnut and Other Fine Hardwoods

Guide to Fertilizing Hardwood Trees for Timber

Missouri Chapter - Walnut Council

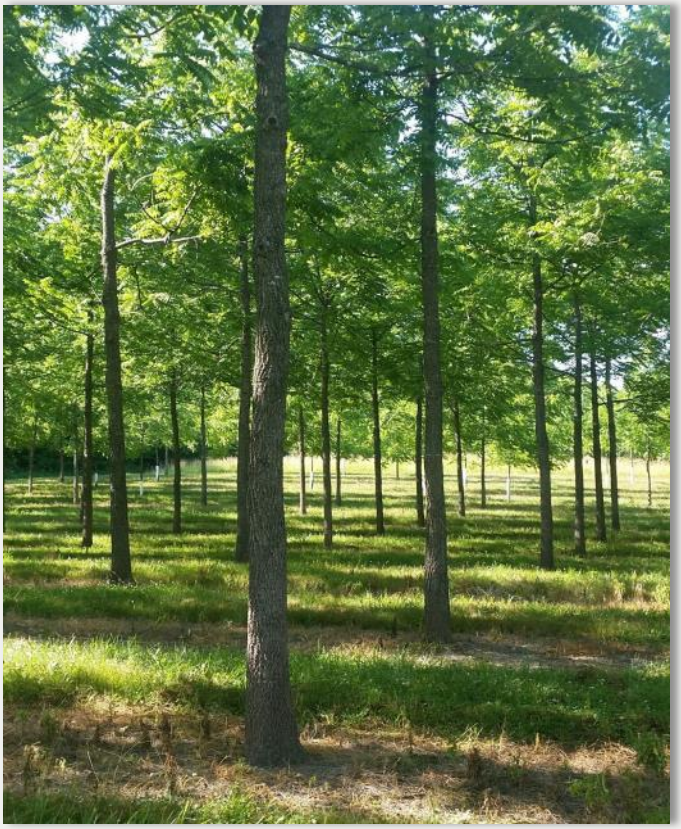
Bob Ball, Member & Woodland Landowner

Jerry Van Sambeek, Member & Retired Plant Physiologist

This paper is based on information from numerous hardwood tree management publications plus lessons learned from members in the Missouri Chapter - Walnut Council. This is not a definitive technical paper, but rather we offer non-technical guidance about the treatment of applying fertilizer to hardwood trees in growing timber.

Field studies have demonstrated applications of fertilizer to *"pole timber"* trees 8" to 12" DBH (the diameter at breast height 4.5' above ground), can increase the tree's diameter, and in most cases, also the height of walnut trees. Many of those studies, however, focused on applying fertilizer to replace the nutrients being removed from a nut crop. Fertilizing is a must if you are growing improved nut varieties of black walnuts or pecans and nut production is your primary source of income from those trees. Other studies have shown hardwood trees grown for timber production can also benefit from fertilizer. The economics of this management practice for timber production only may not be nearly as strong, but tree growth from fertilization can be enhanced when soil fertility is the limiting factor in tree growth. The right trees growing on the right soils with minimal ground cover competition may show limited returns from adding fertilizer because natural fertility is meeting the needs of the trees. The nutrient needs for walnut, oak, and most hardwoods grown for timber and veneer are similar.

The timing of when (in the tree's growth) to fertilize is important. Broadcasting fertilizer under the canopy of saplings with limited root mass or applying to mature trees with naturally slowing growth shows little benefit. Studies show the most effective use of fertilization is for treating *"pole timber"* size trees.



This plantation is approaching pole sized timber. Control tall fescue and other grasses first even before planting and then continue grass control.

Decisions to fertilize hardwood trees should be based on the likelihood of enhancing the growth rates of your trees during the pole timber management period. Basing your decision on expecting a positive economic return for timber production alone may be disappointing. Available field studies are dated, and there are few of them, that address the economics of fertilizing trees for just hardwood timber. ***If tree growth rates are important and the cost factor is not so critical,*** consider looking into fertilizing trees.

However, do weigh this decision more strongly towards fertilizing if you know the planting site has poor fertility, and you have the right tree species growing on the right soils, and you can manage the ground cover competition. If the limiting factor in growing quality timber is fertility and costs are not a concern, you can correct poor fertility.

Hardwoods are likely to produce wider growth rings for several years in response to fertilization. Growth rings that are not regularly spaced may be considered a defect in veneer logs and log buyers may discount the value of these logs if trees are not sold as standing timber. However, growing a larger volume of clear wood faster may outweigh any deductions due to uneven growth. If you will be fertilizing a large black walnut plantation with hundreds of trees, first talk to veneer log buyers and get their input into how your fertilization program may influence pricing when those logs are mature and ready for harvest.

Kill the fescue first!

Removing tall fescue from the area where fertilizers will be applied should be your highest priority. Do this well before nutrients are applied. Few papers have addressed how large an area under a tree needs to be treated. Should it be some portion of the area inside the drip line, to the drip line, or even larger? Most of the tree's feeder roots are within the drip line which for walnut is 2 times the DBH in inches changed to feet plus 5 feet. That can be a lot of bare soil on erodible midwestern soils. Several studies have shown removing tall fescue from the area between every other tree row is adequate. For individual trees treat an area that is sufficiently large to ensure when the recommended amount of fertilizer is applied surface water runoff or leaching into ground water will be minimal.

Begin by Sampling

The amount and analysis of fertilizer to apply should be based on soil fertility and/or plant tissue test recommendations. In lieu of that data you can fall back on rates determined from scientific field studies, but that approach should be a last resort. Both options are discussed here.

First, determine where you will send your samples for analysis. Select a laboratory that performs both soil fertility testing and tissue sampling testing. Plan to always use the same lab since repeated testing provides a historical reference that, over time, can tell a story. Not all testing labs use the same processing steps. Follow their recommendations in how to collect the samples from your planting site.

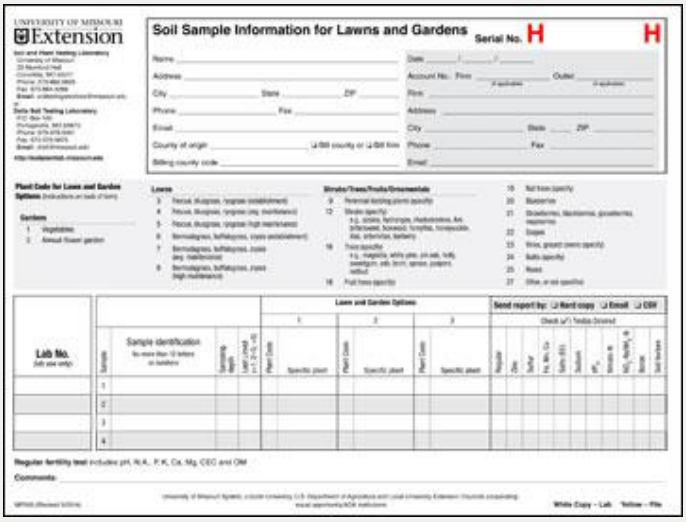
Procedures for correctly taking soil or plant tissue samples are usually available at the testing lab's website.

The following instructions apply to the ***University of Missouri Extension Soil & Plant Testing Laboratory*** for soil testing found at:

https://soilplantlab.missouri.edu/soil/

Obtain a soil sample test form by visiting your nearest MU Extension county office, download and print the form from their website or complete their fillable form online if that feature is available. Explain that you are wanting to do fertility testing for hardwood trees. They will provide you the ***"Soil Sample Information for Lawns and Gardens"*** form also available at: mp0555.pdf (missouri.edu)

The MU lab provides small cardboard boxes for your soil samples. Because trees have deeper roots


Extension

Soil Sample Information for Lawns and Gardens

than agricultural crops, plan to pull two samples. Follow the "Procedures for Taking Soil Samples" printed on the box. Take one sample to a depth of 6" and a second sample from 6" to 12" and indicate that depth in the column under "Sample Depth". Remove the duff layer at the top of the soil cores. After collecting your samples, complete the form by providing your name and contact information in the block at the top. Find the section of the form titled *"Shrubs/Trees/Fruits/Ornamentals"* and look for test #16 for *"Trees"*. Under the column *"Plant Code"* insert the number **16** in the table then write in the plant name such as walnut or oak under *"Specific Plant"*. Check *"Regular"* under *"Tests Desired"* unless you also want additional tests or only a specific test. Results can be mailed or emailed to you in a few days.

For a more thorough analysis of your fertility needs, consider also submitting plant tissue samples to the same laboratory using their "*Plant Analysis Form*".

Fertilizer needs should be based on foliar analyses of leaves collected (*see diagram*) in late June or early July in Missouri. Foliar samples are the best indicator of the current state of deficiencies by analyzing the nutrients available to the plant in the leaves.

Young trees are likely to respond to fertilization if foliar nitrogen is in the range of 2.2 to 2.6 percent, phosphorus is in the range of 0.1 to 0.25 percent, and potassium in the range of 0.75 to 1.30 percent on a dry weight basis. If foliar nutrients are more than these ranges, young trees are unlikely to respond to application of those nutrients. Indirect methods for walnut trees that indicate a need for nitrogen include leaf lengths less than 18 inches (as measured from the terminal pair of leaflets or base of the terminal leaflet to attachment of the petiole to branch) or by yellowing and premature defoliation in late August or early September.

The fees for all tests performed at the MU lab are available at their website or from your local Agricultural Extension Center. Soil and tissue samples can be submitted directly to the lab or dropped off at the extension center where you can make a payment for the testing services.

Follow Lab Recommendations

If you have used a certified testing lab, such as the University of Missouri lab, that does fertility testing for hardwoods, they will give you the test results and instructions on their analysis form to understand the recommendations. The local Extension office (or your testing lab) can explain the recommendations if you have specific questions.

When reviewing your soil test results look first at the soil pH. It should to be between 6.5 and 7.2 for most hardwood species with a maximum range of 5.5 to 8.0. If your test results are below pH 6.5, follow the lab's recommendations to correct soil acidity before applying any fertilizer. Ideally, apply corrective lime applications 6 months before fertilizing to give the lime enough time to neutralize the acidity which will enhance the tree's ability to uptake nutrients. Lowering the pH of alkaline soils is difficult and may require the addition of sulfur, the use of ammonium sulfate rather than ammonium nitrate, or raising the organic matter content.

Applying fertilizer to the planting site does not guarantee the correct amounts of nitrogen, phosphorus or potassium are being taken up by the trees. There should be a direct correlation between fertilizer applied and changes in foliar nutrients, but that may not be the case due to other limiting factors such as poor internal drainage within the soil profile, grass competition, limited sunlight, drought conditions, excessive rainfall, or diseases.

To avoid leaching and minimize volatilization of applied nitrogen, seek out slow-release sources of nitrogen or do split fertilizer applications in a 60:40 ratio applying in spring and late fall. Delay the spring application until the ground thaws and before the grass greens up keeping in mind tree roots can uptake nutrients during the dormant season. Then, make a late fall application in the dormant season after leaves drop but before the ground freezes.

Fertilizer recommendations from the soil fertility lab will include a schedule of application. Plan to reapply fertilizer every 3-5 years. Studies show N is recycled and remains adequate during that time. If you will be needing a large quantity of fertilizer that will be applied using a powered spreader, take your soil test recommendations to your farm fertilizer dealer. Ask if they can provide a blend to meet your needs loaded into a fertilizer buggy you can pull to your farm. This avoids having to purchase bags of specific analysis fertilizers or blending fertilizers a bag at a time which is time consuming and the fertilizer cost per volume is much higher.

The cheapest source of nitrogen will be urea. Typically, most fertilizer dealers sell a 50% urea-based nitrogen product. Apply urea products before a rainfall or incorporate them quickly to minimize runoff and volatilization. High soil temperatures will volatilize urea quickly if it is broadcast on the soil surface. Try to time application to take advantage of ½ inches or more of rainfall within 3 days of application.

Shop for *"slow release"* nitrogen fertilizer. For example, polymer-coated urea, or PCU, can be less costly than other products, and this technology has been proven to be effective at reducing nitrogen loss. ESN, from Nutrien Ag Solutions, is a urea granule contained within a flexible polymer coating that protects the nitrogen from loss

mechanisms and releases nitrogen in response to soil temperature. If you are concerned about possible runoff from your site getting into surface water, PCU type products like ESN, greatly minimize nitrogen contamination. If you are unable to purchase slow-release nitrogen products, then split your applications. A 60:40 split is preferred because trees take up N faster in the spring and you apply lower amounts in the dormant season reducing the risk of winter injury to the trees.

Nitrogen will typically be the most critical and costly nutrient your hardwood trees require. Consider including a nitrogen producing legume cover crop in your tree planting operations. Take advantage of the nitrogen they fix from the atmosphere while also protecting your soil surface from erosion and crowding out toxic tall fescue. Although not a legume, winter or cereal rye provides similar benefits by tying up nitrogen during the dormant season and later laying down a mulch toxic to germinating weed seeds.

Some of the better cover crops in Midwest tree plantings include hairy vetch, crimson clover, black medic, or cereal rye as winter annuals and red clover, Kura clover, sweetclover, partridge pea, or crownvetch (in a mix with another species) as biennials or perennials.

Nodules on annual Balansa clover fix nitrogen from the atmosphere that will be available for tree growth when terminated or reseeds and dies.

This photo shows spring growth at 3.5' in the second year of a walnut seedling grown with hairy vetch established as a cover crop the first year. Control seedlings were only half as tall!

The January and May 2020 issues of the Walnut Council *"Bulletin"* published two tables of common cover crop species providing values for traits such as growing season, drought tolerance, and compatibility with hardwoods in ***Table 1***, and agronomic information including best time to seed, mature height, acceptable soil pH range, and seeding rates in ***Table 2***.

Another approach to a slow release nitrogen source is to add 3 inches of organic mulch beneath the inner canopy of the trees to minimize grass competition and to hold the added nitrogen in place. The practicality of mulching your trees depends on using species that serve as a living mulch (winter rye, spring oats, winter barley) or adding a mulching material available in the needed quantity, row spacing to accommodate equipment, plus the labor that may be needed to spread the mulch to the 3 inch depth around each tree.

Guidelines for Determining Fertilizer Rates for Hardwood Trees

Fertilizer rates per inch of DBH increase over time as the tree canopy becomes larger. Larger *"pole size"* trees require more fertilizer than saplings. The canopy area of individual trees nearly triples in size between 6" and 12" DBH, so the amount of fertilizer applied must be adjusted to account for the sizes of the trees. Once the tree canopies close there is no need to continue increasing rates. The benefit of fertilizing with rates specific to individual size trees is lost. After canopy closure you will be ahead to broadcast fertilizer on a per acre basis.

When planning your fertilization program, *select a few trees or a small area of the planting that will receive the same management but no fertilizer as a control.* Select trees within the planting with and without fertilizer to be measured annually for DBH over the next five years to see if there is a response. Based on your findings estimate if rotation length is reduced sufficiently to offset fertilizer costs before planning to continue with a long-term fertilization program over the entire plantation.

A search of the literature on fertilization of hardwoods yields a wide range in recommended fertilization rates. Recommended rates should be considered a maximum rate since many are based on assuring a measured response and not necessarily what would be sufficient. Rates are usually given on a per tree basis for open-grown trees and on a per acre basis for plantings where canopies are closing or have closed. In closed canopy stands, the amount of nitrogen per acre decreases because the number of trees decreases as trees become larger assuming stands are continually thinned to keep trees in a free-to-grow condition. Based on averages from recommendations found in the literature, ***the following table provides recommendations for open-grown hardwoods AND for closed-canopy plantings or stands.***

For individual trees, apply a complete, granular fertilizer such as 20-10-10 NPK (nitrogen, phosphorus, potassium) using an analysis and rate that provides the pounds of actual N per inch of stem diameter listed in the table.

For example, an open stand of 10" pole-sized timber trees would need 2.1 pounds of N per tree applied within the canopy of the tree every 3-5 years. Applying 10.25 pounds of 20-10-10 analysis fertilizer meets that need. On infertile soils, increase rates 25%, and on fertile soils decrease rates 25%.

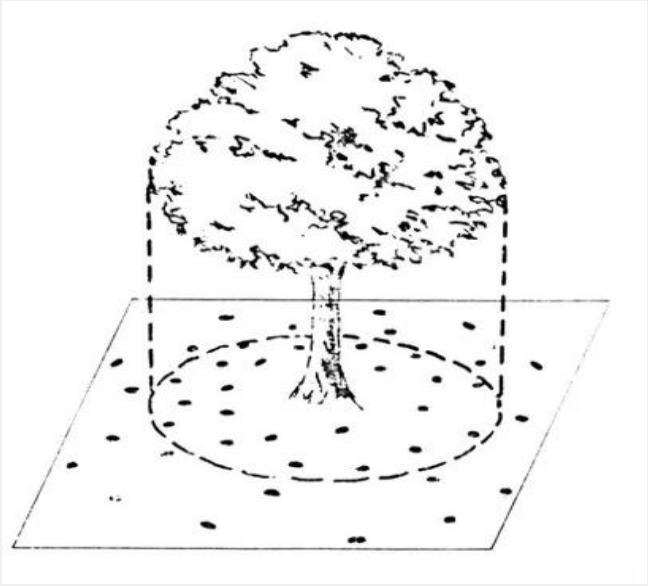
Recommended Nitrogen Rates for Individual Hardwood Trees

Tree Sizes in DBH	Pounds N Per Inch DBH[1]
Seedlings – <1"	0.02 to 0.06
Saplings – 2"- 6"	0.08 to 0.15
Pole-Sized – 8" - 12"	0.18 to 0.23
Sawlog – 14"- 18"	0.26 to 0.28
Veneer – 20" - 24"	0.32 to 0.36
Mature – 26" - 30"	0.23 to 0.25

To determine amount of fertilizer to apply, ***multiply*** recommended pounds actual N per tree by 2 for ***urea nitrogen***, by 3 for ***ammonium nitrate***, by 5 for ***ammonium sulfate*** or ***20-10-10*** NPK, by 8 for ***12-12-12*** NPK, and by 10 for ***10-10-10*** NPK.

Methods of Application

On small sites when fertilizing individual trees use a plastic soft drink container to hold the weight of fertilizer needed per tree. Cut off the top and add fertilizer until you have the amount needed in the container. Make a second cut at the top of the fertilizer. Spread that volume of fertilizer under the canopy of each tree.



Fertilize within the tree canopy.

If you have various stem diameters in your stand, you may need multiple measuring containers marked with the pounds they hold to help ensure you are applying the correct rate per tree. To speed up the spreading process, pour the measured volume into a hand-held rotary seeder and crank while walking around the tree. Tree roots extend somewhat beyond the tree canopy. Try to keep most of the volume within the canopy in areas free of grasses especially tall fescue.

For plantings where tree canopies are closing or have closed apply a complete, granular fertilizer product (contains N-P-K) in a split application as described earlier. Average recommended rates are 110 to 170 pounds actual N per acre for sapling (2" to 6" DBH) plantings, 170 to 200 pounds actual N per acre for pole-sized (8" to 12" DBH) plantings, 160 to 190 pounds actual N per acre for sawlog-sized trees (14" to 18" DBH) plantings, 120 to 150 pounds actual N per acre for veneer-sized (20" to 24" DBH) plantings, and 80 to 100 pounds actual N per acre for mature (26" to 30" DBH) stands.

Apply fertilizer using a rotary type spreader operated between the rows of trees. A battery powered ATV/UTV mounted or PTO tractor mounted unit will give a more uniform coverage and much greater efficiency than using a hand-held spreader. Remember to calibrate your spreader to ensure the output meets the fertilizer recommendations.

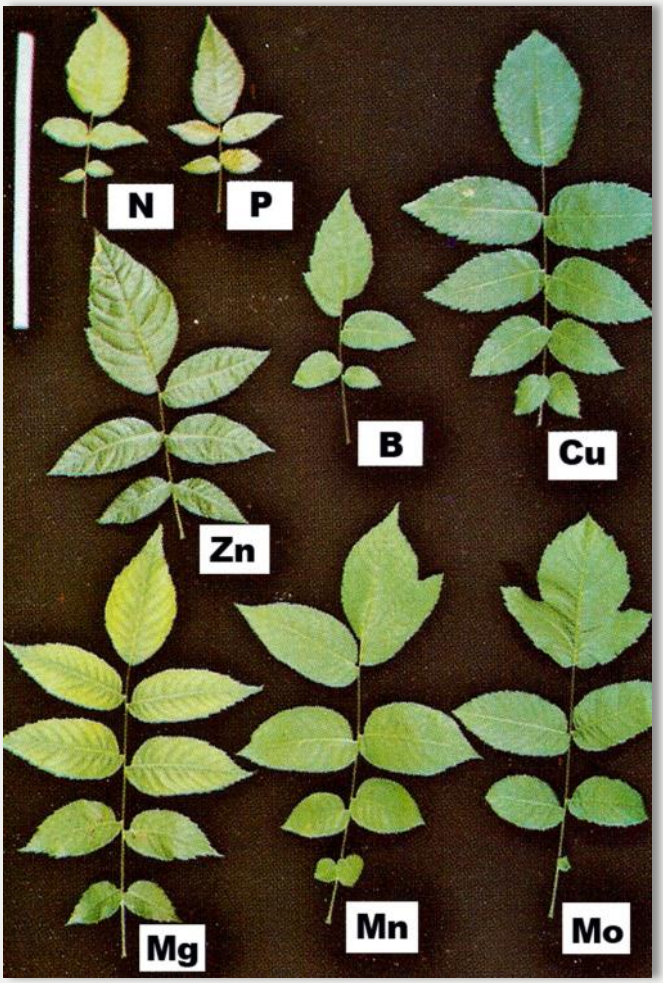
Micronutrients

Your focus in correcting poor soil fertility needs to address the primary nutrients of nitrogen, phosphorus and potassium or N-P-K. There are other lesser known *"micronutrients"* that can also be limiting factors in the growth of your trees and this is especially true in nut production.

We only touch on this complex topic in this paper, but the value of micronutrients should not be overlooked. The emphasis in publications and nearly all internet sites is on trees for nut production. The visual plant characteristics of nutrient deficiencies also apply to hardwoods grown strictly for timber.

Micronutrient demands for nut production are much more important in growing a profitable crop and those needs should not be overlooked.

As the illustration shows, symptoms of severe micronutrient deficiencies can be expressed as changes in leaf length, leaflet number and color, and occasionally shape. These changes reduce the ability of the tree to harvest sunlight and produce the sugars needed for growth and seed production. Visual observations need to be confirmed with foliar testing. If confirmed, consult with the testing laboratory or the nut culture literature on the best ways to correct the deficiencies. In most cases micronutrients are applied in very small quantities as foliar sprays or broadcast application after mixing with a complete NPK fertilizer.



This illustration shows nutrient and micronutrient deficiencies often visible in walnut leaves.

N - Nitrogen, P - Phosphorus , Zn - Zinc, B - Boron, Cu - Copper, Mg - Magnesium, Mn - Manganese, and Mo - Molybdenum express their deficiencies through leaf tissues making the use of tissue testing even more important.

Summary: Key Steps to Good Hardwood Tree Fertility

Tree farmers are faced with many annual tasks to carry out growing quality hardwood timber. We do not have the luxury of planting and walking away from our trees until it is time to harvest. Whether fertilization is even on your task list is an individual decision. If you are not able to fertilize this spring, consider giving that task more priority in the fall.

Plan to fertilize pole-sized timber trees every 3 to 5 years. For nut production, plan to fertilize annually. Remember, if your goal is growing timber, your trees will not be removing anywhere near the nutrients that an annual nut crop will pull from your soil. Seek out special guidance for fertilizing nut trees to achieve maximum production. Be cautious of the reasoning behind any fertilizer recommendations to ensure the criteria for those recommendations match your objectives.

Follow these suggested steps to improve the fertility of your trees:

1. Submit soil samples to a soil fertility lab that provides recommendations for hardwood trees.
2. Consider submitting plant tissue samples to the same lab to supplement your soil test results.
3. Follow soil and/or tissue test recommendations.
4. In the absence of soil test or tissue test results, refer to the options under ***"Guidelines for Determining Fertilizer Rates for Hardwood Trees"*** on page 5.
5. Monitor your tree growth using measurement dendrometers or by taping and recording the DBH on at least a representative sample of your trees annually. Identify a few *"control trees"* that do not receive fertilizer to establish a baseline to help determine if there are measurable results.
6. Do not overlook the importance of micronutrients in your fertility plan, especially when producing nut crops.
7. Ask fellow Walnut Council members to share their knowledge and experiences on this somewhat complex subject.

Good soil fertility is critical in growing quality fine hardwood trees efficiently.

Editor's Note – This guide was prepared in consultation with Missouri Chapter - Walnut Council members and others. *Bob Ball* is retired from the USDA Natural Resources Conservation Service, is a member of the Missouri and Ohio Chapters Walnut Council, and he is a woodland landowner.

Jerry Van Sambeek is a retired plant physiologist who conducted research on walnut and other hardwoods for nearly 40 years with the US Forest Service including 20 years with the University of Missouri Center for Agroforestry.