Guide to Chestnut Production in the Northeastern[1] US

A Farmer-to-Farmer Resource on a Climate-Resilient Tree Crop

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[1] CT, ME, MA, NH, NY, PA, and RI.

The Sustainable Agricultural Research and Education (S.A.R.E.) Northeast Chapter includes 13 states (CT, DC, DE, ME, MA, MD, NH, NJ, NY, PA, RI, WV, and VT), covering a broad range of climates and plant zones (8-4). This guidebook focuses on northeastern states that predominantly have plant zones 5 and 6. There is information in this guidebook that still applies to much of the eastern U.S., although context and location can heavily influence genetic selection, management, and more. This resource is more applicable to the eastern and central U.S. than the western U.S.

Guide to Chestnut Production in the Northeastern U.S.: A Farmer-to-Farmer Resource on a Climate-Resilient Tree Crop by Elodie Eid was last updated in June 2026.

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I. Introduction, Resilience, and Economics (the why)

Introduction and Note from the Author

I've been working in the tree crops industry since 2016, involved in nurseries, orchard implementation, educational events, regional nut processing, tree crop genetic preservation and evaluation, and am co-developing a chestnut-apple-lamb silvopasture farm in western Massachusetts. Through this work, I've witnessed countless farmers become inspired by regional climate-resilient food ways via tree crops with little information or support as to how to have livelihood through that vision. This resource is an attempt to alleviate one of the many bottlenecks that keep us from long-term regional food security that not only prevents land degradation, but actively restores land health.

Because of insufficient institutional support and the variation in which chestnuts are grown, most chestnut farmers primarily learn through experience and rely on fellow farmers for information. Even with the important contributions of several universities and organizations—including Michigan State University, University of Missouri, Northern Nut Growers Association, Chestnut Growers of America, and others—chestnut farming in the U.S. is still largely in its early adoption or experimental phase. I've seen how hard it can be for new growers to access the information they need from a few experienced farmers scattered across their region.

This resource addresses that need. It doesn't offer a definitive best practice for growing chestnuts; instead, it showcases many successful methods in various contexts. With increased interest in chestnut production in the Northeast and the larger U.S., it is imperative that farmers are equipped with the highest quality information possible to make sound decisions. This is particularly important for trees, as the effects of our decisions may not be apparent for many years. The continued viability of chestnut production in the U.S. is contingent upon the relative success of early adopters, and the facilitation of good information at this moment is crucial. My goal is that through this resource, growers can make the best choices for their context and our food system. I hope you find this guidebook helpful.

Honoring Knowledge Keepers and Tree Tenders

This resource is built on the shoulders of the people and the trees who shape and form each other through tending, growth, creation, and harvest. Chestnuts have been intentionally planted and tended by people all over the world for thousands of years. I express my deepest gratitude to all the trees and the people who have brought us all to this collective moment in chestnut partnership.

One of the most famous examples of a chestnut-based culture is Corsica. Although pollen records show the presence of chestnuts since the Neolithic age, in the late 1500s every farmer and landowner in Corsica was ordered by the Governor of Genoa to plant trees, many of which were chestnuts. By the mid-1700s, the vast majority of trees in the region of Castagniccia were chestnuts. Corsicans have a long history of making flour from chestnuts, naming the tree *arbre à pain*, which translates to "bread tree." Nuts are still dried in smokehouses in the mountains today, although both the culture and the trees are declining rapidly.

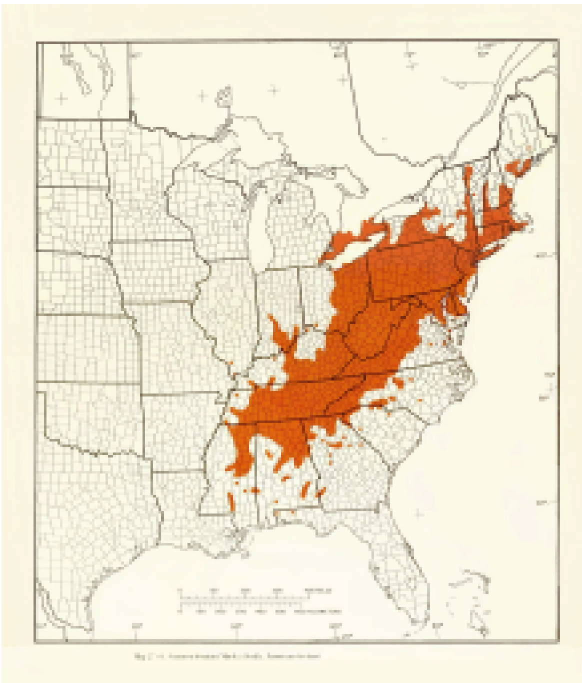
If you'd like to hear the songs and voices of Corsicans of the past, check out this beautiful video of Corsicans in a chestnut smokehouse (u grataghju). Footage of an old chestnut tree is featured at the end.

China has perhaps the longest continuous history of chestnut cultivation. Chestnut trees native to China, primarily *Castanea mollissima*, were first deliberately cultivated as a food plant at least 2,000 years ago (LaBonte et al., 2018), though archaeological findings from the Banpo Ruins of Xi'an suggest the Chinese chestnut has been cultivated for more than 6,000 years (Hu et al., 2022). Because of how difficult it can be to graft or clone Chinese chestnuts, and due to their long history of chestnut cultivation, many experts argue that China has the longest-running mass selection chestnut breeding program ever to exist.

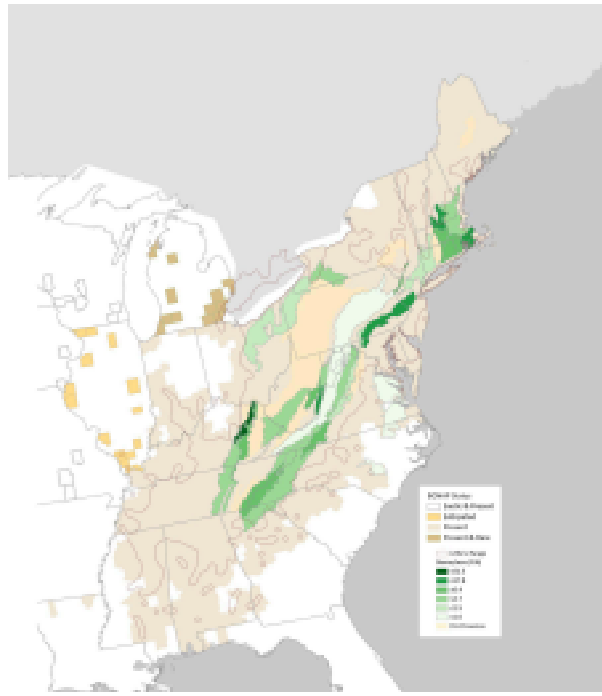
There is also a long history of chestnuts in North America, dating long before it was called North America. The American chestnut (*Castanea dentata*) once numbered nearly four billion trees across the eastern United States. For thousands of years, Indigenous peoples managed the landscape to favor chestnuts, harvesting the calorie-dense nuts that fed not just humans but entire food webs—from detritivore insects to deer, bear, and turkeys. Chestnut shells found at an archaeological site of a human settlement in Pennsylvania date back to 8,000 BCE, and

evidence showing that chestnut trees in Pennsylvania and New York traveled 200 miles in 1,000 years suggests that the Lamoka people migrated the chestnuts themselves (Davis, 2021).

Dozens of different Indigenous groups processed and stored chestnuts, sometimes smoke-drying them and processing into flour. Fire was commonly used as a tool in chestnut stands to burn leaves to help with harvest, kill weevils, and restrict the growth of other nearby trees and shrubs (Davis, 2021). This often created conditions of very large and old chestnut trees with an open understory, something that settlers both admired and abused. European settlers discovered the tree's rot-resistant, straight-grained wood was perfect for everything from beams to railroad ties, many of which remain in use today. By the late 1800s, chestnuts had become central to rural economies where farmers fattened hogs and cattle by allowing them to forage in chestnut forests, railcars overflowed with nuts destined for city markets during the holiday season, and American chestnut lumber was abundant.



1977 Castanea dentata range map (Little)



2018 Castanea dentata range map (Scrivani)

The chestnut blight, caused by the pathogenic fungus *Cryphonectria parasitica*, swept through eastern forests starting around 1900, reducing the American chestnut from forest giant to understory shrub in just 50 years. A second pathogenic fungus that causes ink disease called *Phytophthora cinnamomi* had already been killing trees from the roots up in the southern range for decades. Damage from chestnut blight is severe, but the blight can't kill underground root

systems, allowing stump sprouts to regrow. The species is now considered to be functionally extinct where the trees are not able to reach a size where they can produce seed, although there are some rare exceptions. Though there are still American chestnuts growing in forests, no new chestnut lumber has been sold in decades. There has been a dramatic reduction in domestic chestnut consumption and familiarity. Since 1983, The American Chestnut Foundation has been working to restore blight-resistant chestnuts to eastern forests through breeding and biotechnology.

Since the late 1700s, breeders and propagators in the U.S. have been working with multiple species of chestnut to facilitate a healthy and robust chestnut crop in both farm and forest contexts. There have been a handful of chestnut farmers and researchers over the past few decades who have been instrumental in creating the rise in the chestnut industry today. As someone who has been able to connect with and glean directly from experienced chestnut farmers and researchers, I recognize that this resource would not be possible without their efforts and generosity.

I would like to give special thanks to Greg and Amy Miller of Route 9 Chestnut Cooperative and Empire Chestnuts for their endless humility, thoughtfulness, curiosity, and openness. The knowledge they harbor has been pivotal in the evolution of chestnut farming in this country, and the lineage of their exceptional trees exists in orchards across the country and will hopefully continue for centuries. Their capacity to remain in an endless learning process with these trees is deeply inspiring, and their willingness to share what they've learned with anyone who asks creates ripple effects of generosity throughout our community. I would also like to thank Bob Stehli, whose precision in his breeding work and deep love for the trees has inspired young chestnut farmers to carry on a legacy of unprecedented chestnut breeding work. His generosity has also been deeply inspiring to our community, and the work he is doing in his lifetime may deeply impact both our future and the future of generations to come. There are others like Dr. Sandy Anagnostakis, the late Dennis Fulbright, the late J. Russell Smith, Buzz Ferver, Roger Blackwell, Tom Wahl and Kathy Dice, Michael Nave, and countless others. A whole book could be written about the initiatives of dedicated and passionate breeders, propagators, orchardists, researchers, and land tenders working toward growing chestnuts in North America.

There is a continuous theme of generosity in our community that is deeply humbling. When offering compensation and thanks to those with experience, the answer is often, "Someone else got me started and shared with me everything they know, so it only feels right to pass it on."

This resource attempts to "pass it on" to whoever may need it. Thanks to the integrity of those who came before us, our community has the foundation to work in cooperation for a better future. We thank you all for giving us this hope and purpose, the most valuable gift of all.

Chestnuts and Agroforestry

The majority of chestnut farming in the U.S. is currently orchards where there is only one tree crop and the understory is not managed or utilized for a specific purpose. However, chestnuts have a high potential for a diversified agricultural system, and many farmers are exploring chestnuts in the context of agroforestry. Below are two technical definitions of agroforestry.

The USDA definition of Agroforestry: Agroforestry is the intentional integration of trees and shrubs into crop and animal farming systems to create environmental, economic, and social benefits. It has been practiced in the United States and around the world for centuries.

University of Missouri Center for Agroforestry definition of Temperate Agroforestry: Intensive land-use management that optimizes the benefits (physical, biological, ecological, economic, social) from biophysical interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock.

By these definitions, a mono-canopy (only one tree crop) chestnut orchard with a mowed understory that's not harvested for hay or grazed by livestock is not considered to be agroforestry. This is unfortunate, because there is potential for significant land health improvement and carbon sequestration through a mono-canopy system. Not only could someone be growing chestnuts, but they could also be growing microbes, fungi, and invertebrates while improving water holding capacity, percolation, and organic matter. One could challenge these definitions and argue that such a system can bring the same benefits, and potentially more, than some systems technically classified as agroforestry. For example, does a mono-crop wheat field with sparsely integrated rows of chestnuts have more biodiversity and less erosion control than a densely planted chestnut orchard with a highly diverse non-crop understory? Does a livestock pasture with shrub windbreaks have more income streams than a mono-canopy chestnut orchard? If you add beehives to a mono-canopy chestnut orchard, is it now agroforestry? It is important to challenge our definitions of agroforestry while also

acknowledging the importance of these definitions in order to access funding opportunities through USDA, NRCS, and other institutions.

Certainly, chestnuts do not have to be grown only in mono-canopy orchards. Alley cropping, silvopasture, multistrata agroforestry, and other agroforestry systems can be compatible with chestnuts. Chestnuts have the potential to bring a substantial revenue stream while also providing shade for livestock, building soil, preventing erosion, sequestering carbon, and more (see Agroforestry Systems for more info). Although many of the farmers interviewed for this resource are not technically agroforesters, their work and the chestnut trees themselves can be applied to agroforestry systems with great effect.

Although agroforestry has been practiced for millennia all over the world, it is relatively rare in the U.S today. Modern agriculture has been optimized around commodity crops such as corn, soybeans, and wheat that benefit from economies of scale and have established markets, insurance programs, and government subsidies. Agroforestry systems typically require higher upfront investment, have longer time horizons before returns, and don't fit neatly into existing crop insurance or subsidy programs. Banks and lenders also understand conventional row crop operations better, making financing more challenging. This in combination with the homestead-era push to clear land for farming created a cultural association between "productive farmland" and open fields. Trees are often seen as obstacles to remove rather than integrate. This mindset still influences how farmland is valued and perceived. These barriers—from financial and policy gaps to cultural perceptions and knowledge gaps—have slowed agroforestry adoption, with this resource addressing the latter challenge. However, climate concerns and soil health movements are starting to shift attention towards agroforestry, and interest is growing.

Chestnuts in the Context of Climate Change

Chestnut trees play an important role in climate mitigation. Trees remove carbon dioxide from the atmosphere through photosynthesis and store that carbon in their trunks, branches, roots, and in the soil around them. Unlike annual crops that must be replanted each year, chestnut trees continue accumulating carbon year after year for their entire lifespan, which can span for centuries. This makes chestnut orchards effective long-term carbon sinks while simultaneously producing a nutritious staple crop. By developing a regional staple crop, there is less dependence on imported crops and more resilience in our regional food systems.

One of the main reasons chestnut farming is growing in popularity is because of its adaptability and climate resilience. Although they are generally drought tolerant and have other resilient traits, there are important aspects about chestnut trees that make them susceptible to extreme weather events. For example, trees are susceptible to legacy effects—lingering impacts of environmental conditions that can last for years.

Compared to annual crops, tree crops can be dependent on the growing conditions of previous years. We often think of woody perennials as inherently climate resilient since they are more likely to survive an extreme weather event than an annual crop. Trees have built-in mechanisms that help adapt to environmental conditions. However, these mechanisms often favor the survival of the tree over fruit and seed production, potentially resulting in poor crop production. Also, breeding happens at a longer time scale than annual crops. Chestnuts generally take five to seven years to bear a crop, and it takes many additional years to fully evaluate the performance of a tree. Selecting trees for climate change adaptation occurs on a much longer time scale than annual crops. However, having a tree that continues to thrive and produce well though decades of extreme weather events gives much more direct evidence than the performance of an annual crop in one year.

One big advantage of chestnuts is the potential for high genetic diversity in production orchards. Many eastern U.S. chestnut farmers plant chestnut seedlings instead of cloned, genetically identical trees (see Seedlings versus Grafted Trees for more info). They often intentionally plant trees densely and cull for the best performing trees over time. Although many growers in the eastern U.S. plant pure *Castanea mollissima* (Chinese chestnut) seedlings, there are many complex hybrid cultivars and seedlings commonly planted that include genetics from several species. This creates a highly diverse genetic pool of which there can be a wide variety of responses to disease, pest pressure, and extreme weather events. For every potentially damaging event, growers observe exceptional trees and select for them in their orchards. Early adopters such as Bob Stehli in Ohio and others will use seeds from heavily culled chestnuts for future plantings. This then contributes to the next generation of chestnut genetics that are more regionally adapted.

As climate patterns become less predictable, traits that breeders previously overlooked or considered neutral may prove unexpectedly valuable. What seems like a minor characteristic today could become essential for survival and productivity under future conditions. Having a

large pool of traits to choose from is one of the most resilient qualities a crop can have, and the fact that seedling orchards have been proven to be financially viable for many chestnut farmers is exceptional amongst tree crops. This is one of the strongest cases for chestnuts as a climate resilient crop.

Not all farmers in the eastern U.S. plant seedling orchards. The majority of chestnut growers in Michigan plant grafted (cloned) chestnut orchards of primarily Japanese × European cultivars. They have particular conditions and circumstances that have led them to this planting scheme. Interestingly, these farms have also had success through a completely different strategy. See Michigan Growing Practices for more info.

Response to Drought

Growers commonly observe high drought tolerance in chestnut trees within orchard and nursery contexts. Chestnut trees will continue to grow well in drought conditions, and I have personally observed significant new growth on trees in pots with no watering for several weeks. Many farmers in the Northeast will plant bareroot trees with no irrigation and still experience great establishment and growth rates. It is also very common for chestnut orchards to produce a good crop during a drought year. One chestnut farmer in Italy experienced a three year drought and the trees still produced a crop (M. Bozzolo, personal communication, November 23, 2024). The following account is from a Northern Nut Growers Association report by Chestnut Charlie's in Kansas (NovoGradac & Milks, 2016):

We have also endured severe multiple-year drought, including in 2012 the worst heat and drought since the Dust Bowl days. Once or twice our neighbors' corn turned bleach-white from heat and drought in July while the chestnuts endured and still delivered a crop of chestnuts.

There can be significant differences in drought tolerance between species, within species, and between individual trees (Eriksson et al., 2005; Nie et al., 2024). Growers commonly observe significant differences between individual trees in orchards, especially in seedlings orchards. There can also be dramatic differences in how trees perform in drought depending on the health of the soil. The more organic matter in soil, the higher the water holding capacity, and therefore the more moisture available to trees. Deep, well-aerated soils also encourage deep rooting, allowing trees to access deeper water sources. One study found that Chinese-American chestnut hybrids that were inoculated with ecto-myccorhizae (fungi) were able to recover significantly

faster from drought than trees that were not inoculated, highlighting the importance of good soil health (Aryal, 2017).

Chestnut growers have long associated drought years with smaller nut production, but the relationship between environmental stress and nut size proves more complex than initially apparent. Amy Miller of Route 9 Cooperative has observed that crop load appears to be the primary driver of nut size, with drought playing a secondary or interactive role.

A heavy crop load can result from trees having strong reserves and favorable conditions during flowering and fruit set, leading to an abnormally high number of developing nuts. Some cultivars also show genetic tendencies toward consistent heavy cropping with smaller nuts. When trees produce large quantities of nuts, available resources are distributed across more developing fruit, resulting in smaller individual nut size regardless of water availability.

Understanding nut size patterns matters for market planning. Typically smaller nuts (under ⅞-inch diameter) are not sellable as fresh nuts, but they are advantageous for flour production since they dry more quickly and uniformly. Route 9 Cooperative currently produces chestnut flour from nuts that are either too small to sell fresh or have minor defects, demonstrating how size variation creates value-added opportunities rather than just waste. See Chestnut Flour for more information.

Route 9's production data from 2023–2025 illustrates how crop load and drought interact to influence size distribution:

2023 (**baseline year with normal conditions**):

- Small (<⅞"): 14%
- Medium (⅞–1"): 41%
- Large (1–1⅛"): 41%
- Extra Large (>1⅛"): 4%

2024 (**heavy crop load during drought**):

- Small: 22%
- Medium: 48%
- Large: 26%

- Extra Large: 3%

2025 (light crop load during continued drought):

- Small: 11%
- Medium: 42%
- Large: 39%
- Extra Large: 8%

Amy Miller theorizes that favorable growing conditions in 2023 and the spring of 2024 enabled trees to build strong reserves, leading to the heavy flowering and fruit set observed in 2024. The concurrent drought likely stressed the trees during nut development, compounding the size reduction from the heavy crop load. The 2024 drought appears to have depleted tree reserves sufficiently to limit the 2025 crop load. Despite continued drought in 2025, the lighter crop allowed trees to allocate more resources per nut, producing a size distribution comparable to the normal baseline year (A. Miller, personal communication, January 19, 2026).

This three-year sequence demonstrates the challenge of predicting chestnut production outcomes. Current-year nut size reflects not only present-season conditions but also the previous year's environmental factors and their effect on tree reserves, called legacy effects. Route 9 has observed trees requiring multiple years to fully recover from severe drought (A. Miller & G. Miller, personal communication, October 14, 2024), meaning the impacts of a single stress event can ripple through multiple production cycles.

The combination of legacy effects, variable environmental conditions across growing seasons, and the high genetic diversity present in commercial chestnut orchards creates widely varying drought response experiences among growers. What appears as conflicting observations about drought and nut size often reflects different points in multi-year production cycles and different cultivar responses rather than contradictory evidence.

Time of Bud Break and Flowering

Chestnuts break bud, or begin vegetative growth, later than most trees. This includes not only common fruit tree crops like apples but also native trees such as maples and birches. Chestnuts typically break bud shortly after oaks and right before hickories depending on species and conditions. In the Northeast, this can be in late April to mid-May. This results in chestnut trees also flowering later than most trees. All chestnut species, except the everbearing *Castanea seguinii*, bloom in early summer from mid-June to early July in the Mid-Atlantic and Northeast, occurring earlier in the South. This is much later than other commercial tree crops such as apples, evading potential frost damage to flowers that can occur in spring. However, young shoots of chestnut trees that eventually bear flowers are highly sensitive to freezing temperatures. Any temperatures at or below 28°F can damage these shoots, even though actual flowering won't occur for several more weeks. Chestnut shoots are actually more frost-sensitive than those of most fruit trees. The key advantage chestnuts have over other tree crops is their later budbreak timing. By breaking bud later, they reduce (though do not eliminate) the window of vulnerability to spring frosts that can damage developing vegetative growth and flowers, greatly affecting the season's nut crop.

Fortunately chestnut trees can produce "insurance buds" or "backup buds" that can create a new shoot with flowers if the original shoot gets damaged. Growers can encourage the production of insurance buds by increasing the amount of light into the crown in the canopy through pruning and adequate spacing of trees (see Bud and Shoot under *Castanea* Characteristics).

In 2023, chestnut farmers across the Northeast experienced severe crop failure due to a late hard freeze after a particularly warm spring. The warm, early spring triggered the trees to break bud earlier than usual. When the late freeze occurred in mid-May, the tender, green shoots were already well developed and vulnerable. Climate projections for the Northeast indicate milder winters, earlier springs, and increased temperature variability (see this climate action tool from Massachusetts Wildlife). These shifting patterns are expected to increase the risk of freeze damage to chestnut trees.

As will be a continuous theme in this resource, how well chestnut trees can adapt to late freeze can vary greatly between species and between individuals. See Evaluating Trees for more information about cold hardiness.

Thrives on Sloped, Marginal Land

Using more land for farming in ecologically sound ways is important when creating a regionally based food system that is less affected by global supply chain disruptions that may occur due to climate change. Most of the land in the Northeast is sloped, rocky, and generally not compatible

with tillage agriculture. Chestnuts can do well in depleted, shallow, rocky soils as long as they are well drained and acidic (see Site Analysis). One grower in Connecticut has converted a deeply compacted and depleted 30-year-old motocross track into a chestnut orchard and his trees are thriving (J. Spielman, personal communication, July 3, 2024).

Crops like corn and hay are often grown on sites where they cause significant environmental damage and require intensive management—sloped fields where tillage accelerates erosion, depleted soils that demand heavy fertilizer applications, marginal land with poor drainage, or shallow topsoil that necessitates constant amendments. These sites require substantial fossil fuel inputs for repeated tillage and fertilization. Converting these degraded hay and corn fields to chestnuts offers a lower-maintenance alternative that simultaneously controls erosion and reduces dependence on external inputs while producing a crop. It is also possible to still produce annual crops, hay, and pasture in between rows of chestnut trees (see Interplanting and Alley Cropping).

Even though chestnuts do well on marginal land, it doesn't necessarily mean you should specifically choose a depleted piece of land to plant a chestnut orchard. If you are able to plant chestnuts on rich, well drained soil with high organic matter, the trees will generally grow faster and produce more. This partially has to do with organic matter and water holding capacity, dramatically impacting microbial and fungal health of the soil. Many Missouri chestnut farmers are planting orchards on well drained, silty rich soils with great success.

Chestnut Economics[2]

In 2018, the Savanna Institute conducted an impact investment plan. The follow is a summary of their findings on market potential for chestnuts in the U.S. (Davison et al., 2021):

The US is the only country in the world that has an appropriate climate for chestnuts but not a significant chestnut industry. It produces less than 1% of total worldwide production. The US currently consumes 0.1 lbs per capita per year, and the majority of chestnuts consumed are imported. A total of 20,000 acres of production (based on annual yield projections of 2,000 lbs per acre) would be required to meet current domestic demand. As of 2018, there are only 4,228 acres in production nationwide.

[2] Although 20 years old, this Chestnut Market Analysis from University of Missouri may provide helpful context. Here is a more up-to-date summary of chestnut economics by Propagate.

Additionally, chestnut demand within the U.S. is expected to increase, and in their analysis the Savanna Institute projected TAM (total addressable market) for the following tiers:

1. Direct Sales to Existing Customers
2. Expanded Production to meet growing demand of U.S. consumers
3. Processed Chestnuts
4. Commodity Markets, Animal Feed, Starch, and Tannins

Metric	**Tier 1 (0.1 lbs per capita)**	**Tier 2 (0.5 lbs per capita)**	**Tier 3 (1 lb per capita)**	**Tier 4 (1 lb per capita plus starch and industrial uses)**
Target volume (lbs)	40,000,000	164,000,000	400,000,000	20,000,000,000
Area (acres)*	20,000	82,000	200,000	10,000,000
Number of Trees (48/acre)	960,000	3,936,000	9,600,000	480,000,000
Value**	$200,000,000	$820,000,000	$2,000,000,000	$100,000,000,000
Growth Multiples vs. Today	4.73X	19.39X	47X	2365X

**acreage projections conservatively assume mature orchard yield of 2,000 lbs/acre*

***value projections conservatively assume $5/lb*

The Agricultural Census for 2022 reported 4,322 acres of bearing chestnuts and a total of 35,484 acres of bearing and non-bearing chestnuts nationally. In the Northeast alone (using this resource's definition of Northeast), there were 365 acres of bearing chestnuts reported and 2,028 acres of bearing and non-bearing chestnuts reported. Take into account that this doesn't necessarily mean there's 2,000 pounds (Savanna Institute's metric of average production) produced for every acre reported through the census. Based on Savanna Institute's estimate of 20,000 acres to meet current domestic demand, one could extrapolate that five to ten years from now, the current per capita consumption could be satisfied with domestic production.

Chestnut Market Dynamics and Expansion

As Austin Unruh of Tree for Graziers cautions in this article, it is possible that the price of chestnuts will drop significantly as supply increases (see Pricing below for more information). However, it is also possible to greatly increase the per capita consumption. Current annual per capita in the U.S. is 0.1 pounds whereas in Europe it is 1.0 pound and in Korea 4.0 pounds (Wallace, 1987). Market expansion could have a large impact on the future of the chestnut industry in the U.S., and there are other qualities about chestnuts that significantly impact market dynamics.

Chestnuts are a fresh nut that require refrigeration for good quality unless made into a shelf stable value added product (see Cold Storage under Harvest, Handling, and Processing). When fresh chestnuts are imported from China, Italy, or Japan, they are typically treated with methyl bromide as per Animal and Plant Health Inspection Service protocol (Davison et al., 2021). This not only impacts overall nut and nutritional quality but also potentially human health. Also, it is rare for chestnuts to be refrigerated in grocery stores in the U.S., and this greatly increases chances of off flavors and mold. This is partly due to lack of domestic familiarity with chestnuts. There is a large need for education around proper storage for consumers and producers.

When presented with fresh, high quality, local nuts, consumers are not only more likely to buy them, but they are also more likely to pay a higher price. A survey found that choices of consumers were more heavily impacted by origin and production process than price (Cernusca et al., 2012). In general, locally grown chestnuts and organic practices were preferred which can greatly impact regional market expansion and negate the importation of chestnuts. The study also found that there were significant differences between first-time buyers and repeat buyers with first-time buyers having more sensitivity around price (Cernusca et al., 2012). This could signify that customers might be willing to pay higher prices after trying good quality, fresh chestnuts for the first time. Premium prices are justified not only by quality and freshness, but also by timing. Domestic chestnuts can reach market in peak condition before imports arrive.

Many chestnut growers observe that the majority of chestnuts imported into the U.S. are likely B-grade nuts, a common pattern with imported agricultural products.

The practices of the farm can also have a large impact on prices, and there is a premium price for organic chestnuts. In a study by the University of Missouri in 2005, it was found that certified organic growers were able to sell chestnuts for 25% higher than chestnuts that were

grown conventionally (Gold et al., 2005). See Pricing below for more information on price variability.

It is important to recognize that the source and quality can greatly impact demand, and that the demand can also greatly increase if first-time customers are introduced to high quality nuts. Based on my personal experience of working at many educational events, the majority of Americans have never even had a chestnut before, let alone a good quality chestnut. Chestnut farmers and processors should be prepared to invest time and energy in educating customers and building markets, although this can be very demanding on farmers.

Conversely, customers from cultures with chestnut food traditions already know the value of fresh, good quality chestnuts and will travel great distances, sometimes 5–6 hours (Dice & Wahl, 2019; G. Miller & Revord, n.d.). Many chestnut farmers in the eastern U.S. have had great success by tapping into these markets, and the demand can be remarkably strong. Route 9 Chestnut Cooperative in Ohio sells 100,000 pounds of chestnuts annually, typically selling out within a couple weeks of posting inventory online (A. Miller & G. Miller, personal communication, October 14, 2024). Red Fern Farm in Iowa requires customers to make advance reservations for u-pick appointments due to high demand, with some customers driving up to 5 hours and returning year after year to harvest large quantities (Dice & Wahl, 2019). Growers like Greg Miller of Route 9 and Tom Wahl of Red Fern Farm consistently report being unable to meet demand, often with minimal marketing effort required. For growers who can connect with these communities, the market often exceeds supply.

The production of added value products can also greatly expand market demand. Chestnuts are different in that they are higher in carbohydrates and lower in fat compared to walnuts, pecans, and other tree nuts. Since it is starch dominant, they have a wide range of potential added value products and are considered to be more of a staple crop like corn or wheat. Called the "bread tree" in Italy and France, chestnuts have been processed as a staple crop for thousands of years all over the world.

Potential products can include:

- Chestnut flour
- Chestnut polenta
- Peeled whole chestnuts, frozen or canned

- Dried chestnuts kernels
- Chestnut flakes
- Various desert based products such as candied chestnuts and chestnut puree
- Chestnut miso
- Chestnut honey[3]

Chestnut flour is a very versatile gluten free product that can be used in baking, a trait that's increasing in demand amongst American consumers. Additionally, the production of flour provides an opportunity for farmers to sell nuts that they cannot sell otherwise in the fresh nut market. This can include small nuts, nuts with variable quality or small defects, or nuts that have been minorly damaged by harvesting equipment. The formation of cooperatives that include processing for flour could be vital for the longevity of chestnut farms. At Route 9 Cooperative in Ohio, they buy chestnuts that are unsellable as fresh nuts from members to process into flour. This has been particularly vital for members during drought years which can cause trees to produce smaller nuts in higher quantities than usual. Breadtree Farms in Salem, New York, is building a processing facility for chestnut flour production. The facility will have capacity beyond their own harvest, allowing them to purchase chestnuts from other growers in the region. The production of chestnut flour can not only potentially expand the market but also be a vital tool for ensuring the longevity of farms producing a staple crop during a time with more frequent extreme weather events (see Chestnut Flour under Other Value-added Products for more information).

Another potential solution to regulate supply and demand dynamics is the formation of a formal marketing organization. Such organizations can coordinate promotional campaigns, conduct consumer research, and build brand recognition for an entire crop. However, they typically require grower assessments or fees, and their effectiveness depends heavily on industry structure, market conditions, and member participation. Whether such an organization would benefit the emerging chestnut industry remains an open question worth considering as production scales up. Co-ops can also play a crucial role in regulating market saturation (see Cooperatives and Aggregators below).

[3] Honey made from the pollen of chestnut trees is highly regarded and common in Europe. However, it is questionable if this honey can be made from other species of chestnut besides *Castanea sativa*, the European chestnut.

More Consistent than Other Nut Trees

Compared to other nut trees, chestnuts are considered to be most consistent in their production year-to-year. Other nut trees, such as oaks, walnuts, and hickories, tend to have more off years.

Chestnut trees are accepted as annual producers among growers worldwide, though comparative studies across nut tree species are lacking. The pecan industry has quantified this phenomenon through "alternate bearing indexes" assigned to specific cultivars, suggesting genetic control of bearing patterns. Chestnut bearing patterns appear more influenced by environmental conditions than genetics, though more research is needed. This environmental sensitivity means that while chestnuts are more consistent than other nut trees, they still don't reliably produce the same quantities every year. Weather and climate conditions can significantly impact crop load.

One prevailing theory for alternate bearing in nut trees centers on carbohydrate depletion. Because nuts ripen late in the season and demand substantial carbohydrates, trees cannot fully restore reserves before dormancy. This has been demonstrated in pecans through leaf removal experiments that induced severe alternate bearing, while early nut thinning minimized it (Sparks, 1974). Similar controlled experiments on chestnuts could reveal whether their more consistent bearing results from different carbohydrate dynamics, less resource-intensive nut production, or other physiological mechanisms.

Farm Financial Modeling

Starting a chestnut farm can be challenging for many reasons, one of which is that farmers must be prepared to make no revenue from chestnuts for at least six years. Chestnuts can start bearing as soon as year 6, with some exceptional cases starting sooner. Grafted chestnut trees have been known to start producing at year 3 or 4. If trees have had a slow start, they can take as long as ten years to start producing. It typically isn't until year 10 that trees start producing substantially, creating significant revenue. Alley cropping and silvopasture can help alleviate delayed profits, but these farming systems require other sets of skills, expertise, and equipment, creating significant demands on farmers. Land partnerships involving farmers with multiple enterprises could be explored.

Below is a case study of profits and losses from Bob Stehli's Ashland Orchard at Wintergreen Tree Farm in Ohio. This shows how long it took for the farm to start gaining significant revenue while also demonstrating the non-linear and variable nature of chestnut production.

Ashland Orchard Summary:

- *Began planting in 2003*
- *Planted 25 acres over 4 years at 20′ × 20′ spacing (109 trees per acre; 2,725 total)*
- *Land was previously used for corn production*
- *By year 16, average production was 1,600 lbs per acre*
- *Total costs by year 13: $320,073*
- *Total revenue by year 13: $473,915*
- *Net profit did not occur until year 12*
- *Net profit by year 13: $153,843*
- *Initial establishments costs: $130,500*
    - *Land: $75,000*
    - *Fencing and land improvements: $13,000*
    - *Chestnut bare root seedlings: $22,500 ($8.25/tree)*
    - *Planting: $4,000*
    - *Initial fertilizer and grass seed: $16,000*
- *Cost of maintenance and production for first 13 years: $189,573*
    - *Includes mowing, fertilizer, spraying, pruning, harvesting, and processing*

Things to take note of when analysing this case study:

- Inflation and cost of land has increased dramatically since the establishment of this orchard.

- Costs can vary greatly depending on your location. For example, the installation of deer fencing is generally lower in the Midwest than in the Northeast. Route 9 Cooperative spent $615 per acre on a metal wire fence with pressure treated posts for 65 acres that was installed by an Amish crew in 2017. Even these lower prices have practically doubled since 2020 post-Covid. Prices in the Northeast today can be around $3,000–$6,000 per acre for the same fencing. Many chestnut farmers in the Northeast resort to tree tubes for this reason. See Deer Protection under Establishment for more information.
- Costs can vary greatly depending on management styles and choices.

- Even though chestnuts are generally regarded as the most consistent nut crop, there can still be large variation year to year. A chestnut farm needs to be able to withstand big swings in yearly revenue.

Breadtree Farms in Salem, New York, has created an impressive financial model for establishing chestnut farms that is most applicable to the Northeast. Breadtree Farms is not only the largest chestnut operation currently in the Northeast but is also building a processing facility that will have the capacity to accommodate the chestnut production of other farms in the region. They are committed to supporting other chestnut growers and are doing important work to expand chestnut markets. Their model focuses on establishment costs and includes materials costs, labor, and revenue, but it does not include the costs of harvest, processing, or marketing. It is also based on a wholesale price. You can create a copy and adjust the model for your circumstances, and be sure to look at the explainer tab to modify the model for your needs.

Pricing

How well a chestnut farm is able to generate revenue is highly dependent on the market value of chestnuts. You'll notice that in the Breadtree Farms Chestnut Financial Model that they set a conservative wholesale price of $3.50/lb. This is accounting for 10–20% loss through grading, so estimating an actual purchase price of $3.90–$4.40/lb. This would be the wholesale price for a large quantity of chestnuts being sold by a farmer to a processing facility. Currently, retail prices can range anywhere from $5.00–$12.00/lb, varying greatly amongst growers. Below is an online, retail fresh chestnut price comparison analysis of 11 different farms and cooperatives across the eastern U.S. This data was collected in 2025.

Eastern US Online Chestnut Pricing (2025)

Summary of Retail Chestnut Price Comparison:

- Pick-your-own average: $3.93
- Pick-your-own range: $3.25–$4.70
- Not organic certified average: $7.42
- Not organic certified range: $4.48–$12

Year	Avg. $/lb
2023	$5.98
2022	$5.40
2021	$4.75
2019	$4.71
2018	$4.86
Average	$5.14

- Organic certified average: $9.26
- Organic certified range: $5.24–$12.90

Here are tables from Propagate Ag Ventures that summarize data from the FAO, Chestnut Growers of America, and the University of Missouri's Center for Agroforestry on U.S. domestic conventional in-shell chestnut prices from 2018 to 2023.

Cooperatives and Aggregators

Cooperatives play a crucial role in the eastern U.S. chestnut industry by pooling resources for marketing, processing, and cold storage—services that individual growers would find costly or impractical to develop alone. As the industry grows, forming or joining cooperatives may become increasingly important for managing market dynamics and ensuring stable prices. Many people within the industry warn that without coordinated efforts, rapid expansion of the chestnut industry could lead to market saturation and price drops. Cooperatives offer a mechanism for growers to collectively manage supply, diversify into value-added products, and maintain quality standards that protect prices.

Established Cooperatives

Route 9 Cooperative (Carrollton, OH) was formed to address members' need for processing infrastructure and market access. To build their processing facility, members collectively loaned the cooperative which was repaid between 2009 and 2022. This unique financing structure allowed seasonal repayment based on production and yields, with members receiving payment in the fourth quarter once harvest and sales costs were covered. Now that the loan is paid off, the cooperative makes infrastructure investments to avoid generating profit, as cooperatives aim to break even each year. The cooperative determines member payout prices in December after all expenses are paid. If surplus profit exists, it's distributed as patronage dividends based on each member's contribution to the harvest. Their sales are currently 60–70% retail, 30–40% wholesale, and less than 10,000 pounds per year in u-pick.

A key service Route 9 provides is purchasing unsellable, small fresh nuts from members for flour production. This proved especially valuable during years when trees produce abundant but undersized nuts. Grower members see the value of this service even though members are

allowed to sell independently outside of the coop. In one particularly difficult year for Route 9, Bob Stehli of Wintergreen Tree Farm sent nuts to help them maintain customer relationships even though he could have easily sold the nuts independently. Route 9's ability to buy small or extra-small nuts for flour and pay members even a modest rate provides crucial support when growers can't move these nuts themselves. Another major source of support from the cooperative is collective harvest, u-pick, and orchard management. This is due to most members having established orchards all within the same area (A. Miller & G. Miller, personal communication, October 14, 2024). Check out this video from the Woodlanders Series filmed and produced by Costa Boutsikaris about Route 9 Cooperative.

Chestnut Growers Inc. (Clarksville, MI) is a chestnut handling and marketing cooperative established in 2002 with 35 member growers. They have received grant funding for equipment and are established at Michigan State University's Ag Bio Research Center. They are currently the largest chestnut handling facility in the country, primarily handling Euro-Japanese varieties but also accepting Chinese. The cooperative handles over 200,000 pounds annually, with 85–90% sold wholesale to grocery chains, independent grocers, and distributors like Whole Foods and Meijer's, selling wholesale pallets of 1,600 pounds. The remaining 10–15% goes to retail sales. Members pay a $25 one-time fee for one share of stock, with a base target price of $3 per pound. Like Route 9, surplus profits are distributed as patronage dividends based on harvest contributions. Members cannot individually sell chestnuts but can operate u-pick operations. CGI provides its growers with resources on many different topics along with uniform quality control and marketing materials for all growers. Annual meetings and webinars help keep all growers informed on the chestnut industry.

New York Tree Crops Alliance Cooperative (Cortland, NY) is working to process and market chestnuts and other tree crops from growers/members across central New York state. They have developed their processing facility primarily through grant support.

Keystone Tree Crops Cooperative (Berks County, PA) has established chestnut producer members and is accepting new members. They seasonally sell fresh chestnuts and are in the process of developing chestnut flour. They are performing qualitative interviews with current and potential future members to establish protocols and agreements. They also sell other tree crops products such as hickory oil. They have established their cooperative through crowd funding, volunteer efforts, grant support, and have also been granted an operating loan.

Aggregators and Processing Facilities

Several operations function as aggregators without being formal cooperatives. They sometimes perform the same function as cooperatives through trusted relationships and without formalization.

Prairie Grove Chestnut Growers (Columbus Junction, IA) aggregates chestnuts from multiple producers in Iowa including Red Fern Farm. They function similarly to a cooperative where there's coordination on pricing but haven't needed formalization due to trusted relationships with growers.

Breadtree Farms (Salem, NY) is building a grant-funded processing facility that will have capacity beyond their own harvest, allowing them to purchase chestnuts from other growers in the region. They will also be implementing a chestnut flour processing line which has been heavily researched due to the support of their USDA grant. This infrastructure will be vital for expanding flour production and creating markets for nuts that don't meet fresh market standards. Although they don't plan to create a formal cooperative, they are already performing qualitative interviews with chestnut growers in their region to proactively address future needs around handling and pricing.

Big River Chestnuts (Sunderland, MA) is developing processing capacity to serve regional growers and intends to form a cooperative. They are developing the processing facility mostly through grant support and have already purchased a line of equipment.

Treeborn (Jackson & Owosso, MI) is a Michigan-based value-added processing and market-development company supporting perennial tree crop systems in the Great Lakes region. Treeborn works with chestnuts and pawpaws from growers across the Midwest, converting them into shelf-stable and frozen products that require specialized post-harvest handling and equipment. Founded in 2015 in collaboration with the late Dennis Fulbright (Michigan State University), along with Roger Blackwell, Jon Nash, and Brian Polowniak, the company works closely with Michigan State University, Nash Nurseries, Chestnut Growers Inc., and commercial growers to help bridge the gap between farm production and consumer markets by providing shared infrastructure, processing expertise, and market development for perennial tree crops.

Benefits of Cooperative Structures

Chestnut growers particularly benefit from cooperative arrangements for several reasons:

Shared infrastructure costs. Processing equipment and cold storage facilities represent significant capital investments that individual growers may not be able to afford or utilize efficiently at small scale. Cooperatives distribute these costs across multiple farms.

Market stabilization. By coordinating sales and maintaining quality standards, cooperatives can help prevent the price erosion that occurs when individual growers compete against each other or flood markets.

Product diversification. Value-added products like flour require specialized equipment and expertise. Cooperatives can invest in this infrastructure and develop markets that wouldn't be viable for individual operations.

Risk management. Having an outlet for culled nuts, small nuts from drought years, or nuts with minor defects for flour production provides crucial financial stability. Without this safety net, growers might lose significant portions of their harvest during challenging years.

Collective knowledge. Cooperatives create formal structures for sharing information about varieties, management techniques, pest issues, and market conditions—accelerating learning across all member farms.

For growers considering whether to join or form a cooperative, it's worth noting that successful models vary. For example, Route 9's member-financed processing facility and Chestnut Growers Inc.'s wholesale focus represents different approaches for different contexts. The key is matching the cooperative structure to member needs, regional markets, available infrastructure, and available resources. There are also many contexts where the formalization of a coop may not be necessary. Stakeholders can sometimes create the benefits of coops without the formalization through relationship building.

II. *Castanea* Characteristics and Species

Castanea Characteristics[4]

Chestnuts are monoecious trees and obligate out-crossers, meaning they produce both male and female flowers on the same tree but cannot successfully self-pollinate. Pollen spreads primarily via wind with some assistance from insects. All chestnut species are highly heterozygous—that is, individual trees carry two different versions (alleles) of most genes, one inherited from each parent. This high degree of heterozygosity, combined with the obligate outcrossing reproductive strategy, means that genetic variation within each species is remarkably high. Every seedling represents a unique genetic combination, inheriting a distinct mix of traits from its two parents. All *Castanea* species freely hybridize and form fertile offspring, creating a vast genetic base for breeding programs (Bounous & Torrello Marinoni, 2005; Revord et al., 2022). This outcrossing reproductive strategy has important implications for orchard planning and genetic diversity. See Breeding and Genetics for more information.

The outcrossing nature of chestnuts contributes directly to tree vigor through a mechanism related to genetic load. As diploid organisms with two copies of every gene, chestnuts can accumulate deletions and mutations in their genomes without expressing them phenotypically. This allows the trees to "hang on" to genetic variations that might prove advantageous under future conditions, effectively enabling the evolution of novelty. The more genetic variants present in a tree's genome, the more likely it contains combinations that could succeed under changing environmental pressures (J. Romero-Severson, personal communication, August 26, 2025). This system also maintains high genetic diversity across the landscape, as each seedling represents a unique recombination of parental genes. When a chestnut tree receives its own pollen, it triggers an incompatibility response where the pollen is killed as it travels down the style, preventing self-fertilization (P. Rutter, personal communication, May 29, 2025).

[4] For complete information on *Castanea* species, I recommend reading this chapter from Advances in Plant Breeding Strategies: Nut and Beverage Crops written by J. Hill Craddock & M. Taylor Perkins as well as another chapter from Horticultural Reviews, vol. 31 by Giancarlo Bounous and Daniel Torrello Marinoni.

Bud and Shoot

Chestnut trees produce two distinct types of buds: Mixed buds contain both flower and leaf primordia (embryonic tissue that will develop into flowers and leaves), while vegetative buds contain only leaf primordia. Mixed buds are noticeably larger and easy to distinguish. When observing a shoot during the dormant season of a bearing chestnut tree, there are three distinct zones: a basal (bottom) region with a few vegetative buds, a middle "blind" region with no buds where the previous year's flowers were located, and a distal (tip) region with mostly mixed buds. Some trees under certain conditions will develop mixed buds below the tips of shoots. Individual shoots can carry anywhere from zero to five or more mixed buds, depending on vigor and light exposure.

Shoots with only vegetative buds typically occur on very young trees, lower portions of mature trees, epicormic shoots (vigorous shoots arising from dormant buds on the trunk or older branches), and shaded portions of the canopy. Mixed buds develop on well-illuminated shoots, and shoots bearing more than three mixed buds tend to be long, healthy, and receiving ample sunlight.

When budbreak begins in spring, the three most apical (tip) buds almost always break first and simultaneously. Buds below the three most apical buds are typically suppressed. However, if these lower buds are mixed buds, they can serve as “insurance buds”. If the first three buds are killed by frost or other damage, the lower buds can expand, flower, and produce nuts. Trees with numerous mixed buds in these lower positions therefore have built-in frost resilience.

Flower

Chestnut flowers appear on structures called catkins, which come in several forms. On any given shoot, unisexual catkins bearing only male (staminate) flowers appear at the base, while bisexual catkins containing both male and female (pistillate) flowers develop on the distal portions. The number of catkins per shoot typically ranges from 6–16 (Bounous & Torrello Marinoni, 2005).

Compared to other temperate climate trees, chestnuts bloom relatively late in the season. Pollen production typically lasts about a month, while female (pistillate) flowers remain receptive for approximately two to three weeks. Young seedling trees can begin blooming as early as four to

six years of age, while grafted trees sometimes flower at just three years. However, commercially significant production typically doesn’t begin until trees reach eight to ten years of age.

Certain chestnut trees exhibit a tendency to reflower later in the growing season, a trait that appears consistently year after year in trees predisposed to this behavior. Some trees produce male catkins almost continuously throughout the summer. In sufficiently warm climates like California, this late flowering can result in a second crop that matures as late as December.

Chestnut trees produce separate male and female flowers with a significantly larger amount of male flowers. Each female flower’s ovary houses a large number of ovules at pollination time, but typically only one develops into a kernel. There are typically three ovaries that each form into a kernel within a bur (see Nut below). This apparent inefficiency is actually an evolved strategy where the tree invests resources in creating many potential seeds but only brings a few to maturity in each bur based on available resources (Miller et al., 2013).

Chinese chestnut flowers (Miller et al., 2013)

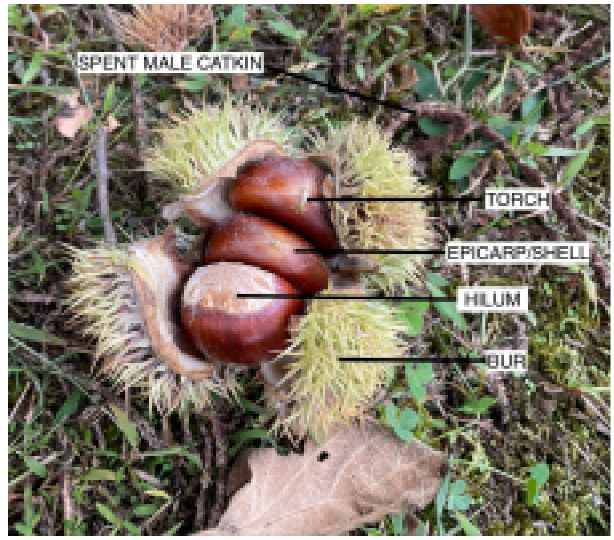
Some chestnut varieties exhibit male sterility, meaning they produce catkins with no functional stamens or with sterile pollen. This is often a function of species hybridity, although often not a guaranteed trait in hybrid chestnuts. Male sterility can manifest in several ways: Some trees produce catkins without any stamens, others develop stamens that shrivel and die before producing pollen, and still others create pollen that appears normal but is actually sterile (Larue et al., 2021; J. Romero-Severson, personal communication, August 26, 2025). This trait warrants attention from growers. Male-sterility is often correlated with high productivity, however correlation is not causation. There are many trees that profusely produce pollen and are just as productive as the average male-sterile tree. More research is needed to understand the impacts of male pollen sterility on productivity. Growers should note male sterility for pollination planning purposes, making sure that there are enough pollen producing trees in their orchards that will cross pollinate with male sterile trees (A. Miller, G. Miller, personal

communication, October 14, 2024; J. Romero-Severson, personal communication, August 26, 2025).

Nut

Chestnuts are different than most nuts in that they are much higher in starch than fat. They are 42% carbohydrate, 50% moisture at harvest, 4% protein, and only 1–2% fat. They are a source of eight essential amino acids, low in sodium (3 mg/100 g fresh weight), and high in potassium (450 mg/100 g fresh weight) (McCarthy and Meredith, 1988). Considered to be a staple food all over the world, they are starchy, delicious, and nutritious. The chestnut "nut" is technically an achene, a simple dry fruit, protected by a spiny cupule commonly called a bur. Each bur typically contains three nuts (chinquapin chestnuts are the exception, producing just one), and burs open along two or four seams when mature. The nut's outer shell, technically the epicarp, has a smooth surface and varies in color from light to deep brown, often marked with more or less prominent stripes. Some nuts have shells covered in fine soft hairs. At the base of each nut sits the hilum, a light-colored scar that marks where the nut attaches to the bur. The apex of the nut consists of the dried remnants of the flower's perianth and styles, forming what's sometimes called the “torch” (Bounous & Marinoni, 2004).

Inside the shell, the seed is wrapped in a thin papery covering called the pellicle. The ease with which this pellicle separates from the kernel varies dramatically by species and individuals—a critical characteristic for commercial production since difficult-to-peel varieties create significant processing challenges. Some varieties produce what growers call “double embryos,” where a single nut actually contains two or more seeds. When planted, these develop into trees with permanently multiple stems, as they're technically multiple individuals sharing a root system. Most nurseries cull these multi-embryo nuts before sale, though some growers deliberately plant them for certain applications (Bounous & Torrello Marinoni, 2005).



(Photo and diagram by Elodie Eid)

The kernel is starch-rich and ranges from white to yellowish in color. The three nuts within a single bur often differ in shape depending on their position. The two outer nuts typically develop one flat side where they are pressed against their neighbors, while the middle nut often has two flat sides. Sometimes a bur will only produce one or two nuts, resulting in rounder nuts.

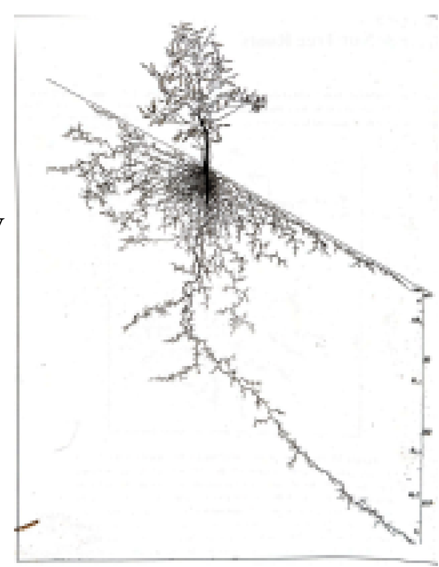
Nut development follows a specific temporal sequence that has important practical implications. The bur and the shell of the nut grow first, before the embryo inside begins substantial development. Remarkably, half of the kernel's mass accumulates during the final two weeks before the nut drops from the tree (Miller et al., 2013). This late-season kernel filling means that any stress during this period—drought, nutrient deficiency, or disease—can significantly reduce kernel size and quality even if the tree successfully carried the crop through most of the growing season.

Form

There is a wide variation of form amongst the chestnut species, anywhere from a towering timber form to a multi-stemmed shrub. There can also be wide variation in form and height within a species. For example, *C. mollissima* (Chinese chestnut) is often described as a somewhat shorter orchard form tree with wide, spreading branches. However, there are timber form *C. mollissima* trees that can reach 70 feet in height. In the Sleeping Giant Orchard in Connecticut, there is a supposedly pure *C. mollissima* 65 feet tall named "Gloria". Interestingly, this tree also happens to be the closest to the forest and is competing the most for light out of any tree in the orchard, potentially forcing its growth upwards. *C. crenata* (Japanese chestnut) is also commonly described as having an orchard tree form but can also display an upright, tall form. Genetics influence the potential growth form of a chestnut tree, though actual form is also heavily impacted by light competition and other environmental conditions such as disease pressure. *C. ozarkensis* (Ozark chincapin) and *C. dentata* (American chestnut) trees today are now much shorter and have more of a shrubby or understory tree form due to chestnut blight (see Chestnut Blight for more information).

Something that all chestnuts have in common is their ability to resprout. Whether resprouting from the base of the tree or sending out multiple sprouts after an above-ground cut or wound, chestnut trees have an incredible ability to regenerate growth. Coppicing and pollarding are both techniques commonly used with chestnut trees, especially in Europe. When stressed, trees

will often resprout from the base. One of the reasons chestnuts are known to reject graft unions is because they can easily concentrate their energy towards resprouts.



Chestnuts are often described as having a deep tap root along with a spreading shallow root system. It is unclear how the root system differs between the different species. However, one can see from this drawing that the majority of the roots on a Castanea sativa tree are in the first 2–3 feet.

Site and Soil Preferences

It is generally accepted that chestnuts require well-drained

Castanea sativa roots (Kourik, 2015)

soils. They have a low tolerance for water logged conditions, and even brief periods of inundation can have a large negative impact on trees. However, there can be variation on the performance of the trees depending on their genetics. Chestnuts also require acidic soils. This can range anywhere from 4.5–6.5 pH depending on the genetics of the trees. For more information, see Site Analysis.

Castanea Species[5]

Castanea is the chestnut genus and contains the following species.

Eastern Asia:

- *C. crenata* (Japanese chestnut)
- *C. mollissima* (Chinese chestnut)
- *C. henryi* (willow leaf or pearl chestnut)
- *C. seguinii* (Seguin chestnut)

[5] For pictures and identifying features of different chestnut species, see this presentation by Sandra Anagnostakis, this presentation from Pennsylvania State University, and this resource from The American Chestnut Foundation and https://tacf.org/chestnut-comparison-chart/.

Europe and western Asia:

- *C. sativa* (European or sweet chestnut)

Eastern North America:

- *C. dentata* (American chestnut)
- *C. pumila* (Allegheny chinquapin)
- *C. ozarkensis* (Ozark chinquapin, also known as *C. pumila ozarkensis*)
- *C. alabamensis* (Alabama chinquapin)

Below are descriptions of the top four species used in North American chestnut cultivation in alphabetical order: *C. crenata* (Japanese chestnut), *C. dentata* (American chestnut), *C. mollissima*

(Chinese chestnut) and *C. sativa* (European chestnut). There is considerable variation between these species and knowledge of these variations is essential for nut cultivation in the eastern U.S.. Not only is there variation *between* species, but also *within* species. Selection and evaluation of individual trees is essential when assessing genetics appropriate for your climate.

Castanea crenata (Japanese chestnut)

General Characteristics & Growth Habit

Many sources claim the Japanese chestnut typically does not exceed 35 feet in height with moderate vigor and has an orchard-type, spreading form (Bounous & Marinoni, 2004; Craddock & Perkins, 2019). However, *C. crenata* also often exceeds 60 feet in height with vigorous, upright growth. In fact, many of the pure *C. crenata* trees in the Sleeping Giant Orchard at the Connecticut Agricultural Experiment Station have an upright form that exceeds 60 feet in height. This species, like other species of chestnut, can display a variety of forms and maximum heights.

Climate & Site Adaptability

C. crenata originates from a climate characterized by mild summers, moderate winters, and high rainfall. Japanese chestnuts can tolerate cooler summer temperatures compared to *C. mollissima*, making them potentially suitable for regions with shorter or less intense growing seasons. Some individuals within the species demonstrate notable cold hardiness, as evidenced by breeding

work conducted by Elwyn Meader in New Hampshire during the 1940s, though cold tolerance varies considerably among genotypes. Much like the form, there can be wide variation within the species. *C. crenata* is also known for higher pH tolerance and wetter soils.

Disease Resistance & Susceptibility

C. crenata demonstrates general tolerance to chestnut blight, though it can be more susceptible than *C.*

mollissima (Bounous & Marinoni, 2004). There can be a wide spectrum of chestnut blight tolerance within the species as well. They also show important resistance to phytophthora root rot and have been extensively utilized in European breeding programs specifically for this trait. Sandra Anagnostakis of the Connecticut Agricultural Experiment Station identified a pure *C. crenata* specimen in the Sleeping Giant Orchard displaying 100% phytophthora resistance controlled by two copies of a single gene, resulting in all seedlings from this tree to be 100% resistant to phytophthora. There were also breeding initiatives that created *C. crenata* varieties resistant to chestnut gall wasp infestations, but unfortunately this resistance did not persist within those varieties long term (see Asian Chestnut Gall Wasp under Diseases and Pests).

C. crenata at the Sleeping Giant Orchard in Hamden, CT.

Horticultural Characteristics

Japanese chestnuts exhibit higher grafting success rates than *C. mollissima*, comparable to grafting success observed with *C. sativa*. The species is most commonly employed in hybrid breeding programs, particularly when crossed with *C. sativa* to create Euro-Japanese hybrids that combine large nut size with improved disease resistance. Because both species are relatively easy to graft, cultivars from this hybridization have been easy to promote, sell, and implement. Due to the hybridization, most of these cultivars are pollen sterile.

Nut Characteristics

Japanese chestnuts are renowned for producing the largest nuts among *Castanea* species, with individual nuts capable of reaching 20 grams or more. The nuts often ripen relatively early in the season, with harvest beginning as early as the first week of September in the northeastern U.S.. This can be a useful trait for areas with a shorter growing season and therefore less time to fully ripen nuts. The nuts are generally considered to be more starchy than sweet and are less desirable for fresh chestnut markets. Also, the thick, adherent, and astringent pellicle presents significant challenges, as it clings tenaciously to the kernel and is generally unpalatable. Some cultivars have been bred for improved peelability, though this easy-peeling trait is controlled by a recessive gene and operates through a different genetic mechanism than the easy-peeling characteristic found in *C. mollissima* (Craddock & Perkins, 2019).

Even though Japanese chestnuts are capable of producing the largest nuts, this does not mean they always produce large nuts. It is not unusual for a pure *C. crenata* tree to produce small to medium sized nuts. They have also been observed to increase the size of their nuts as they age, sometimes splitting the shell of the nuts when they're mature (Nave, 1998). This can cause quality control issues in the nuts and can impact their marketability.

Breeding Considerations for Nut Cultivation

Although *C. crenata* can be lower in nut quality in terms of flavor and pellicle adherence, its blight resistance, productivity, large nut size, and sometimes taller form make it a desirable species to incorporate into a breeding program. In fact, some of the most well-known chestnut cultivars are hybrids between European and Japanese chestnuts and are common in many new orchards across the world.

Castanea dentata (American chestnut)

General Characteristics & Growth Habit

The American chestnut was historically one of the most impressive forest trees in eastern North America, capable of rapid growth to heights exceeding 100 feet with trunk diameters exceeding 10 feet. The species exhibits strongly upright, timber-type growth with excellent form, producing high-quality wood highly valued for construction, furniture, and other applications.

Climate & Site Adaptability

Before the introduction of chestnut blight in the early 1900s, *C. dentata* was a dominant canopy species across approximately 200 million acres, ranging from northern Maine to southern Appalachia. However, the species had already been significantly impacted by *Phytophthora cinnamomi* (ink disease) in the Southeast starting in the 1800s, which caused extensive root rot in low-elevation, moist soils. This earlier disease pressure had already forced chestnuts into drier, upland sites with acidic soils for survival, altering forest composition before chestnut blight delivered the final blow to the dominance of the species (Davis, 2021).

C. dentata in Arboretum Tervuren in Belgium. Photo taken by Jean-Pol Grandmont.

Without disease pressure, *C. dentata* can thrive under an impressive range of climates and soil conditions. They are arguably the most cold-hardy species within the *Castanea* genus with stands in U.S. plant zone 4a which can reach temperatures as low as -30°F.

Areas where American chestnut sprouts are growing in nearby forest often indicates excellent growing conditions for chestnut farmers.

Disease Resistance & Susceptibility

C. dentata exhibits essentially no effective resistance to chestnut blight. The species succumbs rapidly to blight infection, with most mature trees dying within several years of infection. Some trees may tolerate initial infection temporarily, but eventually all die back and resprout from the base. Many trees succumb completely to the disease. Resistance to phytophthora root rot is similarly minimal (see Chestnut Blight for more information).

Due to chestnut blight susceptibility, the American chestnut is functionally extinct as a mature, reproducing tree, though sprouts continue to emerge from surviving root systems. These

sprouts typically grow for five to ten years before succumbing to blight. Extensive breeding programs, most notably those conducted by The American Chestnut Foundation, have focused on backcrossing blight-resistant Asian species with American chestnut to recover American characteristics for forest contexts while incorporating disease resistance. These programs aim to develop trees with at least 15/16 American genetics combined with sufficient blight resistance, though developing trees that can reliably survive and reproduce in forest conditions remains an ongoing challenge.

Horticultural Characteristics

Historical accounts and limited modern trials suggest that American chestnuts graft readily and successfully. Before the introduction of chestnut blight, the cultivar 'Paragon'—a European and American chestnut hybrid (*C. sativa* × *C. dentata)*—was commonly grafted onto *C. dentata* rootstock (Lord, 2015). There has also been successful clonal propagation of *C. dentata* via tissue culture as demonstrated by the Darling 54/58 project.

The Darling 58/54 project—developed by the American Chestnut Research and Restoration Project at SUNY-ESF in Syracuse, New York—has produced genetically modified American chestnut trees for the purpose of complete blight resistance trees for restoration efforts in forest contexts. These trees are not appropriate for nut cultivation and should not be considered by chestnut farmers for the following reasons:

- Nut quality and nut productivity were not taken into account when selecting genetics
- Blight resistance of these selections is questionable
- Use of these genetics will likely result in significantly more expensive plant stock

See https://tacf.org/darling-58/ and https://www.esf.edu/chestnut/index.php for more information about this project.

Nut Characteristics

American chestnuts typically produced the smallest nuts compared to Chinese, Japanese, and European chestnuts. However, the nuts were renowned for exceptional sweetness and flavor quality. The average nut quality across many individuals is largely unknown due the rarity of pure *C. dentata* trees actually producing nuts.

Breeding Considerations for Nut Cultivation

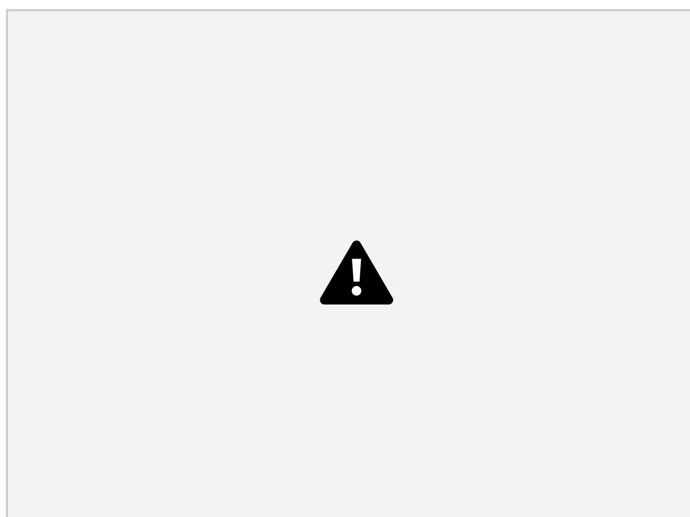
Despite its disease susceptibility, *C. dentata* remains valuable in breeding programs for several critical traits. Its cold hardiness makes it useful for developing cultivars adapted to northern climates, and the timber-form growth habit is highly desirable for dual-purpose (nut and timber) production systems.

Castanea mollissima (Chinese chestnut)

General Characteristics & Growth Habit

Chinese chestnut exhibits significant variation in growth form, ranging from compact orchard types to tall upright forms depending on provenance and selection history. Trees generally display moderate to high vigor with a tendency toward shrubby, multi-stemmed growth in their juvenile years before developing a more defined central leader. The species has been extensively selected for orchard form in China to facilitate chestnut harvest, though timber-form genotypes exist in certain regions, particularly in mountainous areas where chestnuts have been managed for wood production alongside nut harvest. There are plantation forests in China with a 3,040 year rotation with conservative estimates of a harvest volume of 430–3,430 ft^3/acre. There were a total of 12,266,311 acres planted in China of these chestnut plantation forests in 2006 (Del Lungo et al., 2006). There are also trees in China that are known to be 1,000 years old (M. Nave, personal communication, December 20, 2023).

Climate & Site Adaptability



C. mollissima performs best in regions with warm, humid summers characteristic of its native range in eastern China. The species generally requires more heat units and higher summer temperatures compared to *C. crenata* or *C. sativa* for optimal nut development and maturation. Chinese chestnuts commonly imported to the

United States originated primarily from northern areas of the species' geographic range, increasing the probability of Chinese chestnuts performing well in northern climates in the U.S. (Nave, 1998). This species also demonstrates a strong tendency to retain foliage late into autumn and early winter, which can occasionally result in damage from snow loads in northern climates. There are many examples of growers in the northeastern U.S. that have been able to grow pure

C. mollissima and hybrid seedling trees with great success.

Disease Resistance & Susceptibility

C. mollissima is widely considered the most chestnut blight-resistant species among cultivated chestnuts, though resistance is not absolute and considerable variation exists among individual genotypes. This species also demonstrates general resistance to phytophthora root rot. They have proven sufficiently resistant to both major diseases, contributing to their wide use in commercial chestnut production in the eastern United States.

There is a theory that when planting pure *C. mollissima* with *C. sativa* × *C. crenata* hybrids it can create Internal Kernel Breakdown, greatly impacting nut quality. See Internal Kernel Breakdown under Diseases and Pests for more information.

Horticultural Characteristics

C. mollissima presents notable challenges for grafting, with lower initial success rates and higher instances of delayed graft failure compared to *C. sativa* or *C. crenata*. Interestingly, there are accounts of propagators in China having higher success rates of "top working" scion onto mature root stock compared to planting grafted trees (A. Miller, G. Miller, personal communication, October 14, 2024). Fortunately, because *C. mollissima* has been bred for thousands of years for nut production in China, seedlings from trees selected for nut production tend to be quite consistent. Chinese chestnuts are known to have a high number of male catkins and are generally good pollen producers though there are some male sterile cultivars.

Nut Characteristics

Chinese chestnuts tend to produce consistent medium-size nuts, usually weighing somewhere between 10–25 grams with considerable variation influenced by genetics, crop load, environmental conditions, and tree age. *C. mollissima* is known for decreasing nut size as trees

mature. The nuts generally peel easily compared to other species, and the pellicle typically removes cleanly from the kernel. Nut kernel density is characteristically higher than other species, and Chinese chestnuts are generally described as having a sweet flavor. Nuts from northern Chinese populations tend to be smaller and sweeter, while those from southern regions produce larger, starchier nuts (Nave, 1998). The species generally demonstrates excellent storage characteristics, with properly handled nuts maintaining quality sometimes for several months. Chinese chestnut nuts can maintain quality for six to seven months under ideal conditions (B. Ferver, personal communication, November 29, 2023).

Breeding Considerations for Nut Cultivation

C. mollissima exhibits the highest genetic diversity among *Castanea* species. The species is commonly divided into five regional groups: North, Northwest, Southwest, Southeast, and Yangtze Valley Group, though genetic sequencing by Jeanne Romero-Severson has suggested a primary division into two major groups (Dane et al., 2003; Romero-Severson, 2022). This extensive genetic diversity provides substantial potential for continued breeding improvement and adaptation to diverse growing conditions.

Despite its diversity, Chinese chestnuts have been selected for nut production and orchard-type form for thousands of years and can have more consistency amongst selected cultivars. Because *C. mollissima* is known to be more difficult to graft than other chestnut species, this breeding work has happened primarily through planting seedlings from superior mother trees. As a result, seedlings tend to be relatively consistent to their parents, and propagation by seed for production orchards is common.

For growers in the U.S., this means that Chinese chestnut seedlings from selected cultivars for nut production are typically more consistent than other species, and much of the genetics brought to the U.S. from China had a focus on nut production. These trees typically have a lower, more spreading orchard form with good nut quality. Although less common in the U.S., it is possible to come across a range of traits when observing Chinese chestnut trees such as a more upright form. These are important considerations when propagating and breeding with Chinese chestnut genetics.

Castanea sativa (European chestnut)

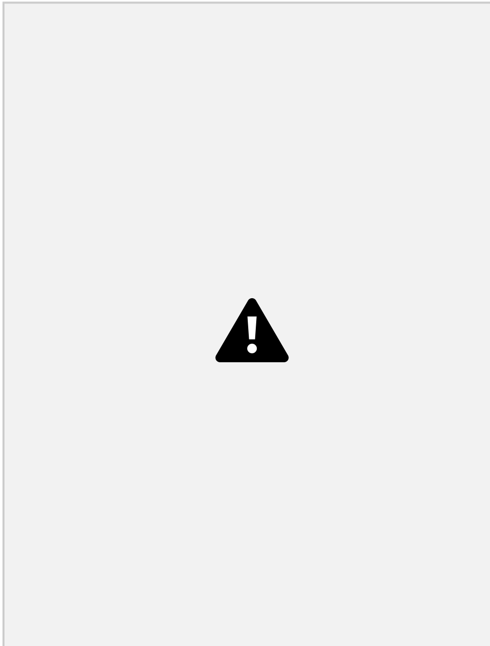
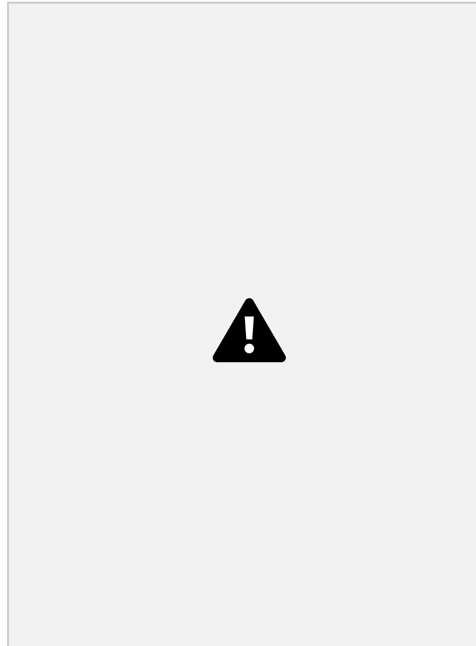
General Characteristics & Growth Habit

Castanea sativa is generally tall and vigorous, sometimes reaching 80 feet in height with an upright form, strong branches, and quality timber. Older trees can exceed 20 feet in diameter at breast height. Healthy trees typically live 400 years, with some reaching 600–700 years when regularly pollarded—an above-ground cutting practice that encourages new growth. The oldest known *C. sativa* is the Hundred Horse Chestnut (Castagno dei Cento Cavalli) on Mount Etna, Sicily, believed to be between 2,000 and 4,000 years old.

Climate & Site Adaptability

The natural range of *C. sativa* is mostly in dry, warm climates although there are more northern and higher altitude populations that experience colder temperatures and higher rainfall. It is generally thought of as less cold tolerant than Chinese, Japanese, and American chestnut, although growers in Michigan have success with Japanese and European chestnut hybrids (*C. sativa* × *C. crenata*) (see Michigan Growing Practices). Pure *C. sativa* species are generally not cold hardy enough for northeastern climates, although it is possible there are outliers within the

species that may do well. However, they are very likely to die from chestnut blight if they don't die from low winter temperatures.

Disease Resistance & Susceptibility

This species is susceptible to chestnut blight and phytophthora, although some genotypes show resistance to phytophthora (Chambers et al., 1995). Some trees also exhibit resistance to chestnut blight through a phenomenon called “hypovirulence” (see Chestnut Blight under Diseases and Pests). Japanese and European chestnut hybrids (*C. sativa* × *C. crenata*) are commonly bred in Europe for combined phytophthora and blight resistance.

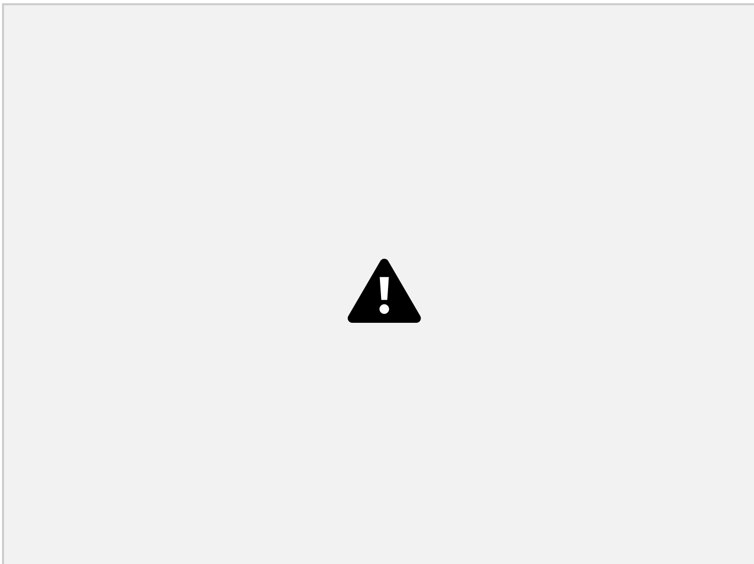
Horticultural Characteristics

C. sativa tends to have a higher grafting success rate than *C. mollissima*. It is commonly crossed with Japanese chestnut (*C. crenata)* to create varieties with good nut characteristics and good disease resistance. Because both species are relatively easy to graft, cultivars from this hybridization have been easy to promote, sell, and implement. Due to the hybridization, many of these cultivars are pollen sterile.

C. sativa is also often propagated by cuttings and seems to have higher success rates of this propagation method than other cultivated species.

Nut Characteristics

Nuts range widely in size, from 10–25 grams in weight. Varieties and landraces within this species fall into two distinct categories, flour type trees and large, *marron* type trees.



Small-nutted types are primarily used for flour production and often exhibit pellicle intrusions into the kernel. *Marron* (French) or *marroni* (Italian) cultivars are known for very large nut size and are typically either sold fresh or processed for other chestnut products besides flour. [The Food and Agriculture Organization of the UN] provides this clarification on this distinction:

The difference between chestnut and marron has been a subject of discussion especially at commercial level. Often marron is used to define very large chestnuts or, as in the case of the French, used to classify chestnuts which do not have signs of episperm intrusion (pellicle which covers the seed) in the kernel or which have a low division percentage (< 12 percent).

However these basic assumptions do not have any biological basis and tend to cause confusion amongst chestnut wholesalers, traders and consumers.

In Italy marron means a particular Castanea sativa *cultivar of excellent quality. Of oblong shape, with a reddish coloured epicarp (skin) that is shiny with dense, often raised stripes and small semi rectangular shaped hilar scar. Large sized marrons are not divided, have a sweet flavour, with the kernel itself free of hollows and easily separable from the episperm (pellicle); it protects the seed and is only superficially attached to the nut which makes it easily removable, by mechanical means, also thereby easing the industrial processing. Marron trees are more demanding as compared to other* Castanea sativa *varieties,* *in terms of climatic and soil requirements, giving a smaller yield as their husks contain only one to two nuts and have sterile male flowers (andro-sterility).*

Breeding Considerations for Nut Cultivation

The disease susceptibility of *C. sativa* to chestnut blight and phytophthora should be the largest consideration when used in breeding work. Breeders and growers should expect higher cull rates with seedlings containing *C. sativa* genetics in areas with heavy disease pressure. Despite these weaknesses, it has many other desirable traits such as upright form, high vigor, and in some cases high productivity.

III. Choosing Your Plant Material, Breeding and Genetics, Clonal Propagation, and Cultivars

Choosing Your Plant Material

For growers in the Northeast and other areas in plant zones 6 and colder, seedling orchards with primarily Chinese chestnut genetics from good sources is a reliable choice. Most will do a mix of pure Chinese chestnut seedlings along with various hybrid seedlings. This recommendation runs counter to conventional systems in most tree crops, where grafted and other cloned trees are standard, and planting hybrid seedlings is exceptionally rare. Understanding why chestnuts are different requires examining available evidence, graft failure, and regional factors that shape how chestnut production has developed across the country.

Seedlings vs. Grafted

The seedling vs. grafted debate in chestnuts is muddied by the fact that growers are often comparing different species, different management systems, and different climates all at once. **In the U.S., there are two main production strategies: seedling orchards of Chinese chestnuts and various hybrids (*C. mollissima* ×), typically grown with lower inputs, and grafted orchards of European-Japanese hybrids (*C. sativa* × *C. crenata*), typically grown with higher inputs.** Pure European and American chestnut trees are not used in production orchards in the U.S. primarily due to their chestnut blight susceptibility. Pure Japanese chestnuts often have poor nut quality and are often not marketable, although there are many exceptions. Euro-Japanese hybrids have chestnut blight resistance, high yields, and better nut quality, taking the best qualities from both species. Michigan has the highest concentration of grafted Euro-Japanese hybrid chestnut production in the country, while other areas in the eastern U.S. rely primarily on Chinese chestnut seedlings, which also tend to have high quality nuts with good chestnut blight resistance.

To compare these systems and declare one "better" is misleading. The species and genetics differ, the management approaches differ, and the climates where they are planted vary. What we can say with more confidence comes from the results of trials by farmers and their success.

Why Seedlings Work for Chinese Chestnuts

Chinese chestnuts are unusual among tree crops in that seedlings from good mother trees tend to produce good, consistent offspring. This trait is often attributed to thousands of years of seedling selection in China, partly because the species has always been difficult to graft, although there are many instances of successful topworking (see Grafting for more information). Even unremarkable Chinese chestnut trees tend to produce acceptable seedlings, and exceptional mother trees often produce exceptional offspring. Offspring from Chinese chestnut bred for production seem to perform more consistently than seedlings from European or Japanese chestnut. This is especially true compared to Euro-Japanese hybrids where seedling performance is far more variable. First generation hybrids, and especially second generation hybrids, between two species tend to be highly variable; a small percentage of the trees can be exceptionally good and a larger percentage are exceptionally terrible (see Hybrids vs. Pure Species Seedlings below for more information).

In China, grafted orchards predominate in warmer southern regions (zones 8–9), while seedling orchards are standard in cooler northern areas (zones 5–7) (J. M. Nave, n.d.). This pattern aligns with the consistent observation that delayed graft failure is more common in colder climates (see Delayed Graft Failure).

Interestingly there are some growers who are trialing grafted Chinese chestnuts. The University of Missouri often recommends grafted orchards of Chinese cultivars and are now being implemented in their region (mostly zone 6 and 7). Badger Johnson of Southern Ohio Chestnuts suspects that grafted Chinese chestnuts will be more productive than seedling Chinese chestnuts at his farm based on trials at the University of Missouri. However, he does point out this could also be due to irrigation and other management differences (B. Johnson, personal communication, December 20, 2024). The University of Missouri currently claims 2,000+ lbs/acre by year 12–15 for grafted Chinese chestnut orchards in their area which is similar to the claims of many Chinese chestnut seedling orchards (R. Revord et al., 2022).

Delayed Graft Failure

The phenomenon of delayed graft failure is central to this discussion. Unlike immediate graft rejection, delayed failure occurs years after grafting, sometimes up to 15 years later, when trees

that appeared healthy suddenly decline or die at the graft union. This makes orchard planning extremely difficult and represents a significant financial risk.

The causes remain poorly understood. Currently, the most accepted theory is that delayed graft failure seems to be exacerbated by stress: water stress, freeze injury, transplant shock, and cold temperatures all increase risk. There is more concern around delayed graft failure in colder climates, which is why seedlings are often recommended in those areas. Chestnuts are vigorous sprouters, and under stress a grafted tree may perceive the graft union as a wound. As a result they can abandon its grafted top in favor of investing in stump sprouts from below the union.

Chinese chestnuts are more prone to graft failure than European or Japanese chestnuts, which graft more easily and heal graft unions faster. This species difference is another reason why Chinese seedling orchards dominate in zones 6 and colder while grafted orchards tend to have more success in warmer regions.

The Evidence

The clearest data comparing seedlings and grafted trees comes from Greg Miller, a leading chestnut breeder and grower at Route 9 Cooperative in Ohio (plant zone 6b). He conducted a direct comparison of grafted Chinese chestnut trees against seedlings from those same parents. He planted grafted 'Peach' and 'Qing' trees alongside full-sibling seedlings from a 'Peach' × 'Qing' cross (PQ seedlings), all in 2014.

Table: *Mean yields of grafted and seedling trees* (G. Miller, 2024)

Tree Type	Planted (2014)	Remaining (2022)	lbs/tree (2022)	lbs/tree (2023)
'Qing' grafts	20	17	17.9	2.9
'Peach' grafts	18	11	6.0	2.9
PQ seedlings	42	40	22.4	9.8
PQ seedlings (minus poor performers)	—	29	28.0	11.9

The grafted trees were slightly larger at planting and came into production earlier, but the seedlings quickly surpassed them in both survival and productivity. Survival rates tell a stark story: 95% of seedlings remained versus 85% of 'Qing' grafts and just 61% of 'Peach' grafts. About half of the seedling trees produced nuts comparable in quality to their parents, and when the poor-performing seedlings were culled from the calculation, the productivity advantage became even more pronounced (G. Miller, 2024).

This experiment is particularly valuable because it compares grafted and seedling trees of the same species and genetic background, isolating the propagation method from other variables. The results support what many growers have observed: **For Chinese chestnuts, seedlings from good parents can match or exceed grafted trees in productivity while avoiding the risk of graft failure.**

A five-year study at Cornell University also found little advantage to grafted chestnut trees over seedling chestnut trees. Grafted trees produced sooner but had high mortality, and overall productivity between the two groups was essentially the same. The researchers concluded there was little advantage to planting grafted trees, especially given the mortality rates (Merwin et al., 2005). However, this study's design makes interpretation difficult. Three of the four cultivars tested ('Grimo 142Q', 'Layeroka', and 'Eaton') are hybrids (although there's some speculation that 'Eaton' is pure *C. mollissima*), and seedlings from hybrid mothers tend to be highly variable. Additionally, the pollen parent was unknown for all seedlings, meaning the seedlings weren't genetically comparable to the grafted trees. The study illustrates the complexity of the debate but doesn't cleanly help answer the seedling vs. grafted question.

Table Summary

Beyond longevity and productivity, seedling and grafted orchards differ in several practical ways. The following comparison simplifies what are actually complex, interacting factors. The sections below address nuances that don't fit neatly into a table.

Factor	Seedling Orchards	Grafted Orchards

Plant stock cost	\$8–\$15 per tree	\$20–\$40 per tree
Years to first crop	4–6 years	3–4 years
Genetic diversity	High (resilience against pests, diseases, climate variability)	Low when planting few cultivars (creates vulnerability)
Nut quality	Variable; depends on parent quality	Predictable
Ripening time	Variable across trees	Uniform within cultivar

Genetic improvement Possible through selection Not possible within orchard

Seedling orchards require active management and observation. A critical point often overlooked is that seedling quality depends entirely on the quality of the parent trees. The variability in seedling trees means growers must plan for culling poor performers. It's prudent to plant with the expectation of removing perhaps 50% or more of trees over time, which requires initial planting at higher densities than final desired spacing (many eastern U.S. growers are planting at 20′ × 20′ initially, then thinning to 40′ × 40′ or wider over time). As Greg Miller of Route 9 Cooperative emphasizes, the seedling approach should be "GROW, then DECIDE. Don't DECIDE, then GROW."

It takes time to identify the best seedling trees. While you can evaluate nut quality and some characteristics in years 1–10, robust productivity assessment really requires waiting until years 11–20. Some early producers may become over-productive with consequent small nut size later, and trees may change their productivity as their crowns develop and go through self-shading and/or mutual shading with neighbors. With proper selection of parent trees and rigorous culling, it's likely a seedling orchard will outperform the orchard from which its genetics were sourced. With record keeping and observation, growers can also identify mother trees that produce exceptional seedlings (called progeny testing), which can accelerate the performance of

their orchard and contribute to improved chestnut breeding for generations to come. See Breeding and Genetics for more information.

Grafted trees can serve specific purposes in northeastern orchards. Despite the risks in cold climates, grafted trees are valuable for seed production (providing known parental breeding value for breeding programs), for preserving specific genetic material for future breeding work, and for trialing cultivars in new regions. If planting grafted trees, be aware that trees of the same cultivar cannot pollenize each other. Dennis Fulbright of Michigan State recommended that pollenizers be within 25 feet of trees to be pollinated, at least when trees are young and producing little pollen.

Ripening time has a large impact on harvest efficiency. Concentrated ripening is a major advantage of grafted orchards. All grafts of the same cultivar tend to ripen together, allowing growers to efficiently harvest an entire block in a short window. This timing may shift year to year depending on weather, and cultivars may ripen differently in different regions, but within an orchard they generally perform consistently (though exceptions have been observed). The variability of seedling orchards complicates harvest because ripening is scattered throughout the orchard over a longer stretch of time rather than concentrated within a certain area and timeframe. Planting seedlings from the same mother tree in blocks might help mitigate this, but offspring do not consistently ripen at the same rate and/or time as their parents.

Grafted orchards don't have to be low in genetic diversity. Low genetic diversity is generally considered the biggest drawback in grafted orchards, which typically have two to three cultivars with one additional cultivar for pollenization. However, low diversity is not inherent to grafted orchards. One could theoretically plant a highly diverse grafted orchard, but finding the plant stock for a large array of cloned chestnut trees, especially Chinese chestnuts, is challenging. Several groups are working on how to effectively clone a higher diversity of cultivars (see [Clonal Propagation] for more information).

Grafted tree consistency has limits. The promised uniformity of grafted trees doesn't always materialize. Growers across the country have observed that the same cultivar can behave differently in different locations, varying in productivity, nut size, ripening time, and even nut quality depending on climate, soil, and especially rootstock. Mislabeled propagation material is common, but these observations are frequent enough to suggest that environmental factors also play a role (J. M. Nave, n.d.; Wahl, n.d.).

Hybrids vs. Pure Species Seedlings

Whether or not a grower plants hybrid or pure species seedlings (or in which proportions) is another wrinkle in the decision making process of choosing your plant material. The answer depends on what traits you're trying to capture and how much variability you're willing to tolerate in your orchard.

Hybrid crosses can bring the best of both worlds. *C. mollissima* contributes excellent nut quality and disease resistance. *C. sativa* offers high yields, and *C. crenata* good disease resistance. *C. dentata* provides timber form and exceptional cold tolerance. Some of the most promising cultivars in the eastern U.S. are complex hybrids. 'ACE', for instance, combines American, Chinese, and European genetics to produce a cold-hardy tree with upright timber form, high vigour, good nut quality, and excellent disease resistance (see Cultivars for the Northeast for more information). When pollinated with *C. mollissima*, 'Luvall's Monster' produces pollen-sterile seedlings, a trait common amongst hybrids and associated with high productivity (G. Miller, 2017). European × Japanese cultivar hybrids are pollen-sterile as well as heavy producers with good disease resistance. They are the most common chestnut cultivars currently planted in orchards in the western U.S., Michigan, and Europe.

Hybrid vigor, or heterosis, occurs when offspring from crosses between genetically distinct parents (in the case of chestnuts, distinct species) exhibit enhanced performance compared to either parent—often showing faster growth, improved disease resistance, or greater productivity. This phenomenon results from the masking of undesirable recessive alleles and favorable interactions between different gene variants inherited from each parent. Some of the most productive and vigorous chestnut cultivars in the U.S., such as 'Tree of the North', are hybrid trees.

Hybrid dysgenesis, the "evil twin" of hybrid vigor, can produce offspring that perform worse than either parent species. Greg Miller observed this phenomenon while examining thousands of *C. sativa* × *C. crenata* hybrids in Switzerland. Many trees remained stunted at only a few meters tall, apparently maladapted to their environment despite both parent species thriving there. This illustrates transgressive segregation, where hybrids express traits outside the range of either parent (G. Miller, personal communication, January 9, 2025).

Trees that consistently produce fewer than three nuts per bur may indicate hybrid dysgenesis, though this symptom can also result from poor pollination or overproduction of burs. Excessive vigor and production (also called overbearing) can also be a common problem with hybrids. When a shoot carries ten or more burs, they often won't fill properly regardless of genetics. However, overbearing can also be an issue with pure species.

These principles point to practical implications for growers. First-generation (F1) hybrids show high variability, and second-generation (F2) show even more variability due to gene segregation. The performance of seedlings from hybrid mother trees is also heavily dependent on the pollen parent. If an F1 is crossed with one of its parents (called backcrossing) or one of its siblings (called intercrossing), the genetic variation of F2s is reduced but still considerably more variable than F1 generations. However, after several generations the performance of hybrids can stabilize.

Overall, most *C. mollissima* hybrids perform worse than pure Chinese chestnuts, though some exceptional hybrids are better than pure *C. mollissima*. In fact, Greg Miller suggests that the way to increase the yield ceiling of Chinese chestnuts is through hybrid breeding (G. Miller, 2017). The challenge is finding those exceptional individuals and propagating them. When planting hybrid seedlings, expect much higher cull rates than with pure species. Bob Stehli planted thousands of 'Layeroka'-group seedlings (complex hybrid with three or more species) and culled 99% of them to his standards. Yet the 1% that remained included some of his best trees (B. Stehli, personal communication, March 3, 2025). This can be accounted for when planning the layout of seedlings in an orchard by mother trees (see Breeding and Genetics for more information).

Table Summary

Trait	Pure Species	Hybrids
Genetic predictability	More consistent; seedlings tend to resemble parents	Highly variable, especially in F2s; a high percentage may be less desirable than parents
Vigor and growth	Typical for species	Can show hybrid vigor (enhanced growth, resistance, productivity) or hybrid dysgenesis (stunted, maladapted trees)
Trait combinations	Limited to traits within the species	Can combine strengths across species (e.g., *C. mollissima* disease resistance + *C. dentata* timber form)
Expected cull rates	Lower	Much higher
Exceptional performers	Rare to find individuals exceeding species norms	Exceptional individuals can outperform pure species, though finding them requires large populations
Production consistency	Generally stable	Can show excessive vigor, overbearing, or inconsistent nut fill

Generational stability	Stable across generations	With selection, stability and performance can increase in generations after F2. Complementary traits of ancestral species can be combined with increasing stability.

Michigan Growing Practices

Michigan has the highest concentration of chestnut production in the country, built primarily around grafted European × Japanese hybrids such as 'Colossal', 'Bouche de Bétizac', and 'Précoce Migoule'. These cultivars are exceptionally high yielding under intensive management. Growers report averages of around 4,000 lbs/acre/year, with top orchards using drip irrigation and fertilization reaching 6,000–7,000 lbs/acre in good years (R. Blackwell, personal communication, January 23, 2025; P. Conrad, personal communication, July 3, 2025; M. Mandujano, personal communication, March 3, 2026). 'Colossal' was the most commonly planted cultivar in the early

2000s, and now many growers are incorporating Euro-Japanese cultivars with superior nut quality.

Several factors converged to shape this approach. The lake-effect climate of the Michigan Fruit Belt moderates temperature swings in ways that may reduce the freeze stress implicated in delayed graft failure, possibly making the region more hospitable to grafted Euro-Japanese hybrids than colder parts of the Northeast. The Fruit Belt also has a long history of conventional fruit production, and growers brought that management culture directly to chestnuts: irrigation, fertilization, herbicides, cloned trees, and mechanical harvest. Michigan State University extension reinforced these practices, guided significantly by the late Dennis Fulbright, whose decades of research and outreach identified cultivars suited to Michigan conditions and established the management systems that became standard in the state.

Another considerable factor is that Michigan is outside the native range of the American chestnut, and therefore has significantly less chestnut blight pressure. Chestnut blight is a disease caused by a fungal pathogen that was introduced in the late 1800s and has rendered the American chestnut functionally extinct (see Chestnut Blight under Diseases and Pests for more information). Euro-Japanese cultivars are generally sufficiently resistant to blight in Michigan, although some cultivars like 'Colossal' are particularly susceptible. It's likely that these same cultivars would succumb to blight in regions such as the Northeast.

The formation of Chestnut Growers Inc. co-op deepened these patterns further. CGI handles the majority of Michigan's commercial crop, and the facility equipment is designed around Euro-Japanese nuts which make up roughly 80% of the volume. The remaining 20% is Chinese chestnut, most of which are from older orchards established in the 1980s and 1990s before Euro-Japanese hybrid cultivars became widely adopted, though some growers are actively planting grafted Chinese cultivars. CGI handles these nuts in a separate stream, reserving the Chinese chestnuts for buyers who specifically request them. The cooperative has expressed interest in growing their supply of Chinese chestnuts (R. Blackwell, personal communication, January 23, 2025).

The relative absence of Chinese chestnuts in Michigan's commercial orchards is partly a product of history. In the 1980s, Bill Wininger distributed poor-quality Chinese chestnut seedlings to growers across Michigan and surrounding states, leaving a lasting negative impression of both seedling trees and Chinese chestnuts more broadly. Dunstan seedlings,

another source not recommended by experienced Chinese chestnut growers, reinforced this perception. Over time, that skepticism has attached more to seedling trees than to Chinese chestnuts as a species. A number of Michigan growers have expressed genuine interest in trialing superior grafted Chinese cultivars. MSU faculty have maintained that mature seedling Chinese chestnuts produce no more than 20–25 lbs/year, a figure that sits well below the 40–60 lbs/year commonly reported by seedling Chinese chestnut growers in other regions. More research is needed to understand what accounts for that discrepancy, whether genetics, management, climate, or some combination (M. Mandujano, personal communication, March 3, 2026; A. Miller & G. Miller, personal communication, October 14, 2024).

What is clearly true is that Michigan Euro-Japanese hybrid cultivar growers are achieving yields that seedling Chinese chestnut operations have not yet matched. According to MSU staff, growers planting grafted Euro-Japanese hybrids in Michigan can expect 50–80 lbs/tree by year 10, well before those trees have reached full maturity (M. Mandujano, personal communication, March 3, 2026). Some growers have also theorized that Michigan's cooler spring temperatures may limit Chinese chestnut productivity in particular, though the data to test that hypothesis are not yet available. Understanding which genetics perform best across the range of U.S.

climates remains an open and important question.

Northeast Growing Practices

Currently, the most common practice in the Northeast is to plant primarily Chinese chestnut and hybrid seedlings orchards. No substantial plantings of grafted Euro-Japanese hybrid cultivar orchards exist in the Northeast, leaving their regional performance an open question. The limited evidence comes from a small number of trials. At Lockwood Farm, part of the Connecticut Agricultural Experiment Station, nine ‘Colossal’ grafts (*C. sativa* × *C. crenata*) were established, eight of which have since been killed by chestnut blight. Blight pressure at Lockwood is notably high, and dozens of ‘Colossal’ crosses on the property now show significant signs of infection. One exception is a tree named “Morse,” another Euro-Japanese hybrid bred by Arthur Graves, which appears to be thriving. At Big River Chestnuts, Jono Neiger planted roughly a dozen Euro-Japanese hybrids, including ‘Silverleaf’ and ‘Précoce Migoule’, in 2018. Several of the trees are performing well and began producing 5–10 lbs/year in their sixth season. Unfortunately many of the trees also appear to have considerable blight damage. Blight resistant pure Japanese chestnut cultivars with good nut quality and easy to peel

pellicles are another avenue worth exploring for the Northeast. Broader, more systematic trials would be needed before any conclusions about regional suitability can be drawn.

In the meantime, seedling chestnut orchards from well-selected sources with primarily Chinese genetics have high nut quality and are establishing well across the region. Many growers incorporate hybrid seedlings into their orchards, which provides many benefits, although, as discussed previously, there are considerations to this approach. Also, most chestnut seed stock is sourced from orchards with multiple species. So even if a grower is planting a seedling from a Chinese mother tree, it’s possible that seed is a first generation chestnut. However, popular seed sources from places like Route 9 Cooperative have primarily Chinese genetics with some other hybrids mixed in. Most of the acreage planted in the Northeast is still young and not yet in full production, but a select few older primarily Chinese chestnut seedling orchards in the Northeast and established orchards in similar climates offer an encouraging track record.

For most northeastern growers, choosing Chinese chestnut seedlings is straightforward. They are proven to perform in similar climates, carry no risk of delayed graft failure, are chestnut blight resistant, and cost less to establish. This is not an argument against Euro-Japanese hybrids or pure Japanese cultivars categorically. Growers or institutions with the resources and appetite to experiment could generate valuable data for the region. But for a grower making a 20-plus year commitment with limited capital, seedling Chinese chestnuts **from well-selected sources** represent the more certain path.

Breeding and Genetics

See the Appendix for breeding terms used in this section.

Why Chestnut Farmers can be Amateur Breeders

Most tree crop farmers leave breeding to institutions. They plant named cultivars developed by university programs, trust that the genetics have been optimized, and focus their energy on management. Chestnuts in the eastern U.S. require a different approach. Because seedling orchards are the most practical choice in colder climates, and because seedling performance is variable, every chestnut farmer could essentially become an amateur breeder. Understanding

basic breeding concepts is essential for seedling chestnut growers to make good decisions about which trees to plant, which to cull, and how to improve genetics over time.

The work is simple in theory—plant diverse genetics from good parents, observe carefully, and remove poor performers. A grower doesn't have to conduct controlled crosses or publish research to be a breeder. However, paying attention, keeping records, and making informed decisions culling is a significant amount of work that can pay off over time.

What makes this approach viable is that in chestnuts, particularly *C. mollissima*, pure species seedlings from productive, high-quality parents reliably produce productive, high-quality orchards. Hybrid seedlings have the potential to outperform pure species seedlings but are much more variable. They need to be incorporated in thoughtful ways to increase the productivity of an orchard (see Hybrid vs. Pure Species Seedlings). The range of traits in a seedling orchard is much wider than with grafted orchards, but with good parent selection and rigorous culling, the overall orchard performance can exceed that of the source orchard (R. S.

Revord et al., 2022).

The economic viability of chestnut production increases in proportion to genetic improvement. Research on participatory breeding has shown that grower and breeder interests are complementary. While orchard trees provide financial support for the grower, those same trees can serve as evaluation trials and sources of elite parents for the next cycle of improvement. This creates value for both the individual farm and the broader industry (R. S. Revord et al., 2022). If we were to rely entirely on institutions to provide the information farmers need to establish resilient chestnut orchards, it would take decades, perhaps centuries. Long-term chestnut cultivation in northern climates requires decentralized trials across many sites, and every farm can double as a potential breeding site. Compared to institutional trials where funding can run out, a farm that can support itself ensures the long-term maintenance needed to evaluate tree performance.

Understanding Cultivar Pedigrees

It becomes clear that when planting chestnut seedlings, especially hybrids, it is vital to understand their lineage to predict how they might perform. Unfortunately, the species identification of many cultivars relies purely on phenotypic observation rather than genetic testing. We often don’t know for certain the genetic makeup of named cultivars.

The Chestnut Improvement Network is conducting genetic sequencing to clarify cultivar ancestry, and the work has revealed some surprises. Jeanne Romero-Severson at Notre Dame has found six genetically distinct types of chestnut trees all carrying the name ‘Colossal’ in U.S. orchards (Anagnostakis, 2012). Two types of naming confusion contribute to this problem. Homonymy refers to the same cultivar name applied to different genotypes. Synonymy refers to different names applied to the same genotype. Romero-Severson suspects that rootstock overgrowing the graft accounts for many cases, and apparently this is easier to miss with chestnuts than with other fruit trees (J. Romero-Severson, personal communication, August 26, 2025). For growers, the takeaway is to track lineage carefully and be skeptical of cultivar names from informal sources.

Progeny Testing and Its Value

Progeny testing means evaluating the offspring of a parent tree to determine how well that parent transmits desirable traits. This is one of the most powerful tools available to seedling chestnut growers, and it’s underutilized.

The best way to make mother tree recommendations for seedling orchards is through progeny tests where one grows offspring from a particular tree to assess performance. An important limitation is that we generally don’t know the pollen parent of open-pollinated seeds, and this is half of the picture. A ramet of a progeny tested tree pollenized by different trees will create different results in the performance of its seedlings compared to the seedlings of the original progeny tested tree. The location and associated abiotic factors may also have an influence on seedling performance of mother trees, not to mention all of the abiotic factors influencing where the seedlings are planted. Still, tracking which mother trees produce consistently good seedlings provides actionable information.

Bob Stehli is a chestnut grower who is now in his third generation of an exceptional breeding program. He has done extensive progeny testing of his trees in his Hiram Orchard, which began with 4,425 trees from diverse lineages. Reliable, quantitative, and thorough assessments whittled the trees down to 400, creating an orchard with exceptional nut qualities, high productivity, and high disease resistance. This is arguably the most extensive and thorough selection process of chestnut seedlings in North America. He has since planted and selected offspring of the best Hiram Orchard trees, and through that data he is able to extrapolate which mother trees in the

Hiram Orchard produce good seedlings and how consistently they can produce good seedlings. He has planted the second and third generation of this breeding program in what he calls the Ashland Orchard, with the first generation being the Hiram Orchard.

‘Turtle Party’ is a selection by Bob Stehli and illustrates why progeny testing matters. This tree would likely be overlooked based on appearance alone. It’s smaller than average with moderate productivity in any single year but has exceptional consistency in bearing crops annually. Despite its modest traits, progeny testing showed this parent produced more precocious, productive offspring than any other tree evaluated at the time. Without tracking offspring performance, this value would have been invisible (B. Stehli, personal communication, October 15, 2024, personal communication, October 16, 2024, personal communication, March 3, 2025).

Although the value of progeny testing is clear, it may be too resource intensive for most chestnut growers to implement. However, if a grower is already planning on implementing a data collection process for culling seedlings, tracking which mother tree each seedling came from is easy to add to that data collection.

Hybrid Swarm

Philip Rutter of Badgersett Research Farm in Minnesota takes a different approach to chestnut improvement, one rooted in evolutionary biology rather than traditional selection. Since the 1980s, Rutter has created what are called hybrid swarms by crossing five chestnut species (primarily American and Chinese, with Japanese, European, and Chinese dwarf chinquapin) and allowing them to interbreed across generations. This creates enormous genetic variation, far exceeding most commercial chestnut seedling plantings, with combinations of traits that wouldn't appear in either parent species or simple F1 (first generation) hybrids.

The strategy is to plant large numbers of genetically diverse seedlings at high density, much higher density than most seedling orchards, then let natural and human selection identify superior individuals over time. Dusty Hinz at Thistlerow Chestnuts in Spring Grove, Minnesota, has adopted this approach, planting roughly 363 trees per acre (30 feet between rows, 4 feet within rows) with plans for ongoing selection starting around year 5. At his location, it is likely that pure Chinese chestnuts would have performed poorly in such cold and dry conditions, such as they have at the Badgersett Research Farm. Hence the incentive for implementing such a system to create a new line of chestnut genetics that can tolerate more extreme conditions.

Two factors enable farms like Thistlerow to implement this strategy. **First, trees aren't individually protected from deer browse.** At 363 trees per acre, individual protection would make establishment cost prohibitive. Instead, Thistlerow uses perimeter 3D electric fencing, which prevents roughly 80% of deer browse at a fraction of the cost of permanent fencing. However, areas with severe deer pressure can potentially overwhelm 3D electric fencing (see Deer Protection under Establishment).

Second, vole pressure remains low. Planting at high density makes close mowing time-consuming and costly, so Thistlerow doesn't mow near trees. Typically areas of uncut vegetation can create vole breeding grounds and population spikes. It is common for areas of high vole pressure to damage and kill 5–20% of chestnut seedlings in their first year. Thistlerow is converting old corn and soy fields, which typically have very low vole populations. Farms converting old hay fields or pasture face much higher vole risk that could devastate unmowed seedlings (see Vole Management under Establishment).

When conditions allow and in extreme climates, the hybrid swarm approach could be a viable option. However, it carries significant trade-offs. Extra dense spacing can force early culling decisions before trees can be properly evaluated. Greg Miller notes that while some trees are obviously worth culling early, many can't be fully assessed until year 10. At 4-foot spacing within rows, canopies will touch quickly. The wide genetic variation also creates more risk than typical seedling orchards. There may be greater variation in nut size and quality, presenting challenges for handling and processing. For most Northeast growers in plant zones 5 and 6, planting primarily consistent Chinese seedlings with some diverse material mixed in offers a more practical balance between genetic diversity and orchard uniformity.

Layout and Culling of a Dual Purpose Orchard

If chestnut growers want to have productive orchards that also serve as decentralized breeding sites, there are ways to be strategic with layout that can balance the two objectives. Also, it's very important not to fall behind on culling. Trees that are mature and haven't been thinned can develop tight canopies and lower production. If mature trees are thinned suddenly, they can experience shock and branch tip dieback. Greg Miller theorizes this is due to sudden exposure to increased light. If your orchard has a closed canopy, thin slowly. Removing 30-year-old trees is a lot of work, so consider pre-emptively removing trees when younger (A. Miller & G. Miller,

personal communication, October 14, 2024). Stehli thins trees as soon as canopies touch because crowding can start to affect his data, especially yield data (B. Stehli, personal communication, October 16, 2024).

By strategically alternating seedlings with high variability and seedlings with high consistency, chestnut growers can mitigate excessive opening and crowding after culling. Below is an example of a seedling planting strategy implemented by Breadtree Farms. They recommend 40-foot-wide alleys, advantageous for their silvopasture operation, with 16-foot spacing within the rows (R. Wallack, personal communication, January 6, 2025). A similar layout could be applied to an orchard at 20 × 20-foot spacing, a more common design of chestnut seedling orchards focused specifically on production (see Spacing and Orientation for more information).

AM	AM	AM	AM	AM	AM	AM	AM

1 2 3 4 1 2 3 4

AM	AM	AM	AM	AM	AM	AM	AM

1	2	3	4	1	2	3	4

AM = **Seedlings of Ashland Mix.** A mix of mother trees from Bob Stehli's second generation breeding program. Although there are multiple species in this mix, the genetics are primarily Chinese chestnuts and have gone through a rigorous selection process. This implies that the majority of these seedlings will be good performers with some outliers that are exceptional and some that are undesirable.

1 = Seedlings of 'Gideon'. 'Gideon' is a pure Chinese chestnut known to produce high quality seedlings with exceptional consistency.

2 = Seedlings of 'Hansen'. 'Hansen' is presumed to be a Chinese hybrid with some Japanese and/or American genetics. It is a high producer with a timber form, although it has mild nut flavor. Since it is pollenized by other good quality Chinese chestnuts, seedlings should improve in nut quality although there will be variability in their performance.

3 = Seedlings of 'Turtle Party'. 'Turtle Party' is one of Bob Stehli's progeny tested selections that is known for producing a high percentage of exceptional seedlings.

4 = Seedlings of 'Tree of the North'. A hybrid that is an extremely high producer, consistently 300 pounds per year. Seedlings will presumably be variable in productivity and nut quality, although there will be some with exceptional genetics that will boost the yield of the orchard.

Breadtree's design is able to balance consistency and variability within seedlings. By alternating consistent seedlings with variable seedlings, one can theoretically cull seedlings so that there aren't too many gaps in an orchard or too many good trees in an orchard. This design is also able to take advantage of high quality available seed mixes such as the Ashland Mix while still implementing a selection program that tracks specific mother trees.

Evaluating Trees

Lessons from Greg Miller

Greg Miller's 2017 Northern Nut Growers Association Report "Breeding Chestnuts for Nut Quality and Yield in Eastern North America" distills decades of commercial growing experience into practical guidance for chestnut seedling growers. The principles he articulates provide a useful framework for observing and selecting trees.

Selecting for Nut Quality

He often cites nut quality as being a high priority. It's expensive to grade out bad nuts, maintain proper storage conditions, and lose customers. High yielding trees won't necessarily result in high profits if those trees produce poor quality nuts. This is why nut quality deserves serious attention when selecting parent trees.

Mold and rot resistance ranks as one of the most pressing concerns. Anthracnose, other internal rots, and postharvest spoilage caused by *Penicillium* and *Fusarium* create the biggest problems for growers. Nuts with good resistance generally have a firm texture and dry slowly.

Ease of pellicle removal significantly affects processing efficiency and marketability. Most *C. crenata* and *C. sativa* nuts can be difficult to peel, while most *C. mollissima* nuts generally peel well. This trait strongly influences which genetics are appropriate for different end uses.

Nut shape matters for both mechanical handling and consumer appeal. Round nuts move through processing equipment more easily and are generally preferred by buyers.

Selecting for Yield

For most fruiting tree crops, such as apples, there is a trade-off between vigor and fruit production. Vigorous one-year-old water sprouts normally form only vegetative buds and not fruiting buds. Typically fruiting buds occur on two- or three-year-old wood. Therefore, orchardists often made decisions between vigour and fruit production when pruning. Chestnut trees, as well as other nut trees, produce their fruit (or nuts) on new growth, so vigor and production are linked differently than fruit trees. Generally you need a vigorous tree to produce a high yield, but sometimes overly vigorous trees can cause overbearing.

Greg Miller breaks it down into several components: nut size (grams per nut), nuts per bur, burs per shoot, and bearing shoots per land area. All of these components can affect your total yield. For *C. mollissima*, nut size and burs per shoot are highly variable and often inversely correlated. Meaning growers commonly observe that when a tree exceeds four burs per shoot, nut size decreases, especially with Chinese chestnuts. Miller concludes that Chinese chestnuts therefore have a biological ceiling for yield. It is possible for hybrids to break through that biological ceiling.

Rather than attempting to maximize individual yield components, Miller argues that yield is most efficiently increased by selecting appropriate parents and planting orchards at sufficient density to allow culling of poorer performers. This approach allows growers to identify high-yielding individuals while maintaining adequate nut quality and other desirable characteristics. The key is balancing the orchard with good, consistent producers that yield moderate amounts of high-quality nuts rather than pursuing maximum yields at the expense of quality.

Traits for Evaluation

When observing your trees, systematic documentation creates the foundation for good culling decisions. The following traits are organized by category to help structure your observations.

Traits Important for the Northeast

The traits below are particularly important for growers in the Northeast, but they don't replace the fundamentals. A tree with exceptional cold hardiness isn't very useful if it has poor nut quality, low productivity, or weak disease resistance. Many traits helpful for northern climates relate to phenology, the timing of cyclical events like bud break and nut drop.

- **Maximum cold tolerance:** Determines whether a tree survives in your area. ● **Late spring frost/freeze tolerance:** The new growth of some trees can withstand lower temperatures than others.
- **Early winter/late fall freeze tolerance:** Sometimes trees are not properly hardened off before the first frosts in late fall and will experience some damage. This affects health and productivity but rarely kills trees or prevents the following year's crop. Sometimes trees with a more southern lineage won't harden off in time in more northern climates and the trees die or won't produce nuts.
- **Timing of bud break in spring:** Later is generally safer in spring frost-prone areas. ● **Timing of nut ripening:** Because of the shorter seasons in colder climates, trees that ripen nuts earlier in the season are more advantageous.
- **Response to snow load and ice:** Like oaks and beeches, chestnuts have a tendency to hang onto their dead leaves throughout the winter which can capture more snow load and cause damage. Some trees are more prone to this than others.

General Tree Traits

- **Tree size and form:** Typically orchard type versus timber type with many forms in between.
- **Vigor:** Thick twigs, large leaves, "loose" crown structure often correlate with productivity.
- **Precocity:** Age at first crop, though note the caution below.
- **Crop size by year:** Tracking consistency matters as much as peak production. 68

- **Consistency in nut size**
- **Canopy span relative to production:** This is especially helpful when evaluating trees at different ages.
- **Pollen sterility or fertility**
- **Level of catkin production**

- **Whether nuts fall free from the bur or remain inside**
- **Number of nuts per bur:** Typically three. Fewer can indicate poor pollination or hybrid dysgenesis.
- **Number of burs per shoot:** More than four can correlate with decreased nut size, often called overbearing (see below).

Timber form trees can increase yield per acre and potentially provide an additional timber crop by using vertical space more efficiently and capturing more sunlight. However, most cultivars selected for nut production were not bred for timber form. This is particularly true for Chinese chestnuts, which have been selected for shorter, spreading canopies suited to orchard systems. This orchard form likely reflects traditional Chinese practices involving intensive pruning and harvesting nuts directly from trees rather than from the ground (M. Nave, personal communication, December 20, 2023).

A caution on precocity: Typically when trees start producing nuts, growth slows down. Selecting trees that produce nuts the fastest may actually reduce future nut production. Look instead for trees that are both precocious and vigorous; the combination is more telling than precocity alone.

Consistency in nut size is very important, especially for fresh chestnut sales. Overall, customers tend to prefer medium- to large-sized chestnuts. Many growers prefer trees with a medium crop load that produce medium-sized nuts over trees that produce large crops with variable nut size. Some species change nut size as they age; Chinese chestnuts tend to get smaller with age, Japanese chestnuts tend to get larger (G. Miller, personal communication, July 11, 2025; M. Nave, personal communication, December 20, 2023b).

Overbearing is often listed as a negative trait since it correlates with smaller nuts. However, large crop loads of small nuts could be a helpful trait for chestnut flour production. Interestingly, Greg Miller has observed that trees will often overbear earlier in age and will produce less and larger nuts as the trees get older and start touching canopies. This is likely due

to available sunlight in the canopy. An exception to overbearing and small nut size is European × Japanese cultivar hybrids. These selections can often overbear (around more than four burs per shoot) and still produce large nuts (G. Miller, personal communication, July 11, 2025; M. Nave, 2021). This is likely due to the effects of hybridity.

Pollen sterility is a secondary trait. High productivity is often correlated with pollen sterility. The high productivity of large nuts of European × Japanese hybrid cultivars is often correlated with their pollen sterility (M. Nave, 2021). However, there are many heavy pollen producers that are just as productive, sometimes more so, than pollen-sterile trees. Select for productivity, not pollen sterility. (G. Miller, personal communication, July 11, 2025; J. Romero-Severson, personal communication, August 26, 2025). However, it is important to document pollen status for pollination planning purposes. See Flower under *Castanea* Characteristics for more information on how to identify pollen sterility.

General Nut Traits

- **Nut size**
- **Pellicle removal:** easy or difficult
- **Shell thickness**
- **Nut shape:** round nuts are easier for machinery and more appealing to consumers
- **Single or multiple embryos**
- **Split shells:** can cause dryness and increase mold susceptibility
- **Flavor and sweetness**
- **Kernel texture:** firm nuts often correlate with better storage and disease resistance ● **Kernel color**
- **Storage quality**: how long nuts maintain quality under proper conditions ● **Susceptibility to mold and rot**
- **Drying rate**: nuts that dry slowly often have better disease resistance

Nut size can be difficult to assess because nuts dry out over time, trees can produce different sized nuts in different years, and some species change nut size as they age (Chinese nuts tend to get smaller with age, Japanese tend to get larger).

Pellicle removal is key to get returning customers. The pellicle can be bitter and astringent. When it’s difficult to remove, cooking with fresh chestnuts becomes much more difficult.

Disease and Pest Resistance

Diseases

- Chestnut blight (*Cryphonectria parasitica*) response
- Anthracnose/Blossom End Rot (*Colletotrichum henanense*) incidence
- Phytophthora root rot susceptibility (more relevant in warmer, wetter areas)
- Internal Kernel Breakdown (IKB)
- Brown rot (*Gnomoniopsis smithogilvyi*)
- Postharvest spoilage from *Penicillium* and *Fusarium*

Pests

- Asian chestnut gall wasp (*Dryocosmus kuriphilus*) response
- Japanese beetle damage
- Spongy moth damage
- Potato leafhopper damage
- Shothole leaf miner damage
- Weevil susceptibility

Note overall foliage health, as trees with consistently healthy foliage often have broader pest and disease resistance. See Diseases and Pests for more information.

Other Traits Worth Noting

- Does the tree produce good seedlings? (Progeny testing reveals this over time.)
- Does it graft well?
- Does it root well from cuttings?

Evaluating Trees in Your Orchard

The ability to identify poor performers early and cull them appropriately is one of the most valuable skills a seedling orchard grower can develop. The long term success of seedling orchards largely depends on this process.

In order to properly evaluate trees, growers use various low- and high-tech tools to keep track of individual tree data. Although labeling trees may seem simple at first, any experienced orchardists will tell you it is actually much more difficult than it sounds. Individual labels are easily lost where plastic labels degrade in the sun and aluminum metal labels are oddly desired and damaged by crows and squirrels—stainless steel is far more durable. Maps can be made showing which tree is where relative to the other, but these become quickly outdated as trees die or are removed from the orchard. Growers will often use a combination of these techniques, but if these techniques are contradictory to each other it creates lack of certainty. Highly accurate GPS systems so far seem to be the most reliable way of labeling trees, although the equipment may be too expensive for most growers but could be shared amongst a group of growers. Breadtree currently uses Emlid and Bad Elf for their GPS hardware and uses Sectormentor for their software.

Bob Stehli of Wintergreen Tree Farm does a spray paint system in combination with highly accurate GPS points. He will use different-colored spray paints for different categories (yield, pest resistance, nut quality, etc.) and will mark the top 10% of performers in each category. This system makes it easy for him to quickly identify top performers as he's walking in his orchard.

Properly evaluating trees requires patience. You can't reliably rate trees on their first 2–3 crops, though you can note early bearing as a trait. Precocity is more affected by genetics than environment. However, robust yield assessment may require waiting until crops 11–20. Greg Miller recommends evaluating trees at crop 11–20 for yield, while nut quality and other traits can be evaluated in years 1–10 (A. Miller & G. Miller, personal communication, October 14, 2024).

There's an important caution about selecting for precocity. When trees start producing nuts, growth slows down. This is because nuts are produced on new growth, making growth and production linked (see Lessons from Greg Miller above). Larger trees produce more nuts, and selecting trees that produce nuts the fastest may actually reduce future nut production. Charles NovoGradac and Deborah Milks, growers in Kansas for over 20 years, observed the same pattern. They wrote that "with seedling chestnuts it has been our experience that early-to-bear seedling chestnut trees often become less impressive in later seasons. Mostly they become overproducers of increasingly tiny nuts" (NovoGradac & Milks, 2016). Bob Stehli also notes that precocious trees often fail later in life, sometimes from disease and other issues. (B. Stehli, personal communication, October 16, 2024). Russel Wallack looks for trees that are both precocious and vigorous. The combination is more telling than precocity alone (R. Wallack, personal communication, September 13, 2024).

Evaluating Trees in Your Neighborhood

Don't overlook local genetics. 'Qing', one of the most popular *C. mollissima* cultivars, was found in a backyard in Kentucky. There is huge potential for locally adapted genetics in trees that have been growing unnoticed for decades. However, don't select seed from a tree you've only been observing for one year. Be sure to evaluate trees for several years before deciding to implement those genetics in your orchard.

Old Northern Nut Growers Association annual reports can help identify trees in your area that were documented by earlier growers. When evaluating local trees, consider who is providing the pollen. A tree's performance is influenced by both parents, and in an open-pollinated setting, the pollen sources matter.

Clonal Propagation

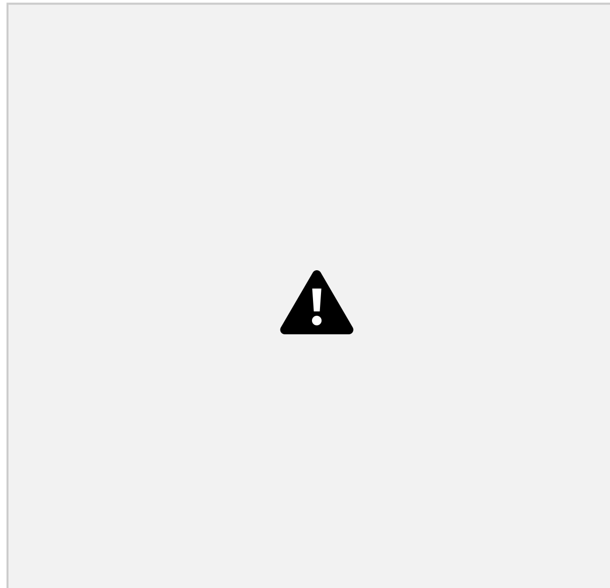
Having an easy way to clone trees is important for growers to participate in breeding efforts and for the chestnut community at large. When a grower or breeder identifies an exceptional seedling through years of observation, the ability to propagate that individual vegetatively allows those specific genetics to be preserved and multiplied. However, cloning chestnuts presents challenges that differ significantly from other tree crops.

Grafting

Grafting involves joining scion wood from a selected tree onto rootstock from another tree, creating a clonal copy with a genetically different root system. The scion wood, usually vigorous one-year-old growth, is sourced from the tree being cloned. This is the most common method of clonal propagation for chestnuts, though success rates vary considerably by species. *C. mollissima* (Chinese chestnut) is known for having lower success rates than other species (*C.*

sativa, *C. dentata*, and *C. crenata*).

Amy Miller notes that grafting goes against chestnut's natural tendency to wall off wounds with tyloses and shed weak branches, so any success at all is somewhat miraculous (A. Miller, personal communication, February 9, 2024). Graft failure can occur initially, within the first growing season after grafting, or be delayed, appearing several years later.



Initial Graft Failure

Several factors contribute to initial graft failure in chestnuts.

Vascular bundle misalignment. Chestnuts have vascular bundles within the cambium layer that can make proper alignment challenging. For successful grafts, the cambium of the scion wood must contact the cambium of the rootstock. If propagators are not aware of these bundles, they can accidentally misalign their grafts. Fortunately, these bundles are visible and relatively easy to see (Huang et al., 1994; M. Nave, personal communication, December 20, 2023).

Genetic incompatibility is often cited as a cause of initial graft failure, especially for Chinese chestnuts, though there is conflicting information on this topic. It is a general rule of thumb that scion wood should be grafted onto the same species, otherwise the graft will likely be unsuccessful. The head of the chestnut repository in Taian, China, assumes that interspecies grafts will fail by five years, so they plan ahead for that eventuality. They topwork all species onto established *C. mollissima* rootstock, expecting their *C. sativa*, *C. crenata*, *C. dentata*, and various hybrids grafted on that stock to fail on average by year 5. However, they do not expect *C. mollissima* on *C. mollissima* grafts to fail (M. Nave, personal communication, December 20, 2023).

Many growers take it a step further and suggest that a scion should only be grafted onto its own seedling (B. Ferver, personal communication, November 29, 2023; Jaynes, 1979). Meaning scion wood from ‘Qing’ should be grafted onto a seedling of ‘Qing’. This in theory limits any genetic incompatibility that may occur. However, in open-pollinated seedling orchards with multiple

species, the unknown pollen parent may introduce genetics into the seedling rootstock that cause complications.

Growers also note that individual trees vary in how easily they graft. Some selections, even Chinese chestnut selections, graft well onto a variety of rootstocks. Other selections make excellent rootstock, with propagators experiencing high success rates when grafting onto them (G. Miller, personal communication, July 11, 2025; B. Stehli, personal communication, March 3, 2025). Whether this relates to genetics or other factors is poorly understood.

Interestingly, a study by Huang and colleagues found that genetic incompatibility was not a major cause of graft failure in Chinese chestnuts. They stated that graft failure is more likely due to the vascular bundles mentioned previously. They also note that graft incompatibility is more of an issue in the U.S. than China, possibly due to additional genetics from other species in the rootstock since the U.S. has orchards with more diversity (Huang et al., 1994). Jeanne Romero-Severson advocates for clonal rootstock to eliminate this potential variable, which would require propagation techniques such as cuttings or tissue culture rather than grafting.

Fungal pathogens and viruses may also contribute to initial graft failure. Amy Miller of Route 9 Cooperative notes that she has seen a decline in grafting success after using scion from the same original tree continuously, and they tend to see better success when using scion from “virgin” stock. Her hypothesis is that by trimming twigs every year from the same stock plants, wounds are constantly open which makes trees vulnerable to pathogens. It may also change dynamics between trees and their endophytes, or fungi that live within plants. Chestnut stems harbor an amazing diversity of fungi, many of which could turn pathogenic when the tree is in a perceived stress condition. She suspects that the longer a stock plant is used, the more potential for pathogens to build up (A. Miller, personal communication, February 9, 2024).

Delayed Graft Failure

Grafted chestnut trees commonly experience delayed graft failure, where trees abandon the graft union several years after the initial graft. Delayed graft failure remains poorly understood but appears to be a stress response. Chestnut trees tend to self-prune when stressed, potentially abandoning grafted tops in favor of rootstock sprouts. Amy Miller notes that trees seem to handle grafting fine without irrigation in some locations, but in areas with more extreme weather, delayed graft failure becomes more common. If people are growing grafted trees in

such climates, they would benefit from added inputs such as regular long-term irrigation to mitigate stress (A. Miller, personal communication, February 9, 2024). See Delayed Graft Failure for more information.

Grafting Guidelines

The following guidelines can be applied to bench grafting (scion wood grafted onto bare-root or potted rootstock) or topworking/field grafting (scion wood grafted onto trees already established in the ground).

In a study by Warmund, Cumbie, and Coggeshall on best grafting practices for Chinese chestnuts, they found that the specific grafting technique is not as important as following these basic rules:

1. The scion bud is fully dormant at the time of grafting.
2. The rootstock is actively growing and does not bleed at the time of grafting. 3. The cambia of the rootstock and scion tissue are properly matched with vascular bundles taken into account.
4. After grafting, the union is wrapped and sealed tightly to prevent moisture loss during callusing and differentiation of developing tissues.

Their research showed that best success is achieved when the air temperature is 26.7°C (80°F) for 10–14 days after grafting. As soon as the scion bud begins to grow, grafts are shaded and the temperature is dropped to 23.9°C (75°F). Cooler temperatures tend to prevent the new scion growth from collapsing as vascular continuity between the scion and rootstock tissues is developing.

In the same study, Warmund and colleagues found that Chinese chestnuts that were bench grafted had a 75% success rate when they were not irrigated after grafting compared to only a 25% success rate for trees that were irrigated after grafting. This indicates that bleeding can be a significant factor when grafting Chinese chestnuts, and this could be a limiting factor to field grafting (Warmund et al., 2011). This is not to be confused with the benefits of long term irrigation after the graft union heals as mentioned in the Delayed Graft Failure section above.

At Southern Ohio Chestnuts, Badger Johnson used whip and tongue bench grafting for *C. mollissima* onto pure *C. mollissima* rootstock. With a 75°F high-humidity greenhouse setup, he achieved a 70% success rate (B. Johnson, personal communication, December 20, 2024).

Topworking

Topworking, or grafting onto preestablished trees in the field, can be an effective choice for propagating cultivars. Many growers have had success specifically with *C. mollissima*, which is particularly valuable given that many growers struggle with bench grafting Chinese chestnuts. Michael Parks has had great success topworking 'Eaton' (a complex hybrid that is suspected to be primarily Chinese genetics) onto pure Chinese chestnuts (Michael, personal communication, November 19, 2025). The head of the chestnut repository in Taian, China, routinely topworks Chinese chestnut cultivars onto Chinese chestnut rootstock with great success (E. Eid & J. M. Nave, personal communication, September 11, 2023). Bob Stehli uses a two-flap bark graft when topworking mature trees (B. Stehli, personal communication, March 3, 2025).

Cotyledon Grafts (Nurse Seed Grafts)

Cotyledon grafts, also called nurse seed grafts, involve grafting scion wood onto the cotyledons (seed leaves) of a germinating seedling, with the cotyledons still enclosed in the seed coat. J.C. Moore of Auburn University developed this technique after observing that cuttings from young seedlings rooted readily while cuttings from old trees were very difficult to root. He theorized that substances in the germinating seed caused the young wood to root readily. In his experiments, Moore removed seed cotyledons from several young seedlings and inserted hardwood scions from bearing trees into the cotyledons. Those grafts with cotyledons attached formed good root systems, while none of the controls without cotyledons rooted.

For best results with chestnuts, Moore found that scions should be collected during the dormant season and grafts made in early-spring. Moore reported achieving a very high percentage of successful grafts with this method (Moore, 1964). Mountain State Chestnuts also advocates for this method and demonstrates it in this video. For more information, check out this resource by Carl Mayfield.

Layering and Cuttings

Layering involves encouraging roots to form on branches or shoots through the addition of soil or other substrates while still attached to the parent tree. Once rooted, the new plant can be severed and transplanted. Cuttings are vigorous shoots cut from a plant that form roots in a controlled setting and are then replanted. In the case of chestnut trees, cuttings are typically taken from the base. *C. sativa* (European chestnut) is more often propagated using this method, though complications are still common. Root cuttings are pieces of roots that are planted to create new shoots.

Overall, propagating chestnuts via cuttings is challenging, but a significant benefit is that the whole tree is a complete clone. If the tree gets cut back or damaged, it will regrow with genetics solely from the parent tree. There is no risk of graft failure or of the rootstock being mistaken for the cultivar. Additionally, propagation via cuttings could be a good strategy for producing consistent rootstock.

After years of farmer-led research, Jeff Zarnowski of Z's Nutty Ridge developed a layering technique for propagating hybrid chestnuts of various lineages with mostly Chinese chestnut genetics that achieved a 44% success rate. Sprouts that rooted successfully showed high root quality. Zarnowski found that the critical factor is timing, and hormone application should occur 60 days before the typical first frost (Zarnowski, 2024). Although a success rate of 44% seems low, the technique is easy to apply and could produce a large number of cloned trees.

The technique involves the following steps:

- To encourage sucker growth, prune the tree back by 30–50% during dormancy.
- In spring before bud break, create a deep mulch ring 6–8 inches deep and 12–16 inches in radius

around the tree. You can use stakes and tarpaper to maintain the shape of the mulch ring. Make sure that the depth of 6 inches is maintained throughout the growing season. Reapply mulch as needed.

- Perform a summer hormone application 60 days before the average first frost using a zip-tie technique.

For detailed instructions, see the SARE project report from Z's Nutty Ridge and the PDF guide "How to Layer Chestnut Trees".

Research by Vieitez has shown that mature *C. sativa* (European chestnut) cuttings stored at -10°C for two months lose their rooting inhibitors. A gradual decrease in inhibition was observed in cuttings stored in the cold from two to five months. Not only are the inhibitors deactivated and converted to inactive compounds, but new rooting promoters (coniferyl and salicyl alcohols) are formed that are not present in fresh cuttings of chestnut.

Vieitez also found that juvenile cuttings, which root easily, lack significant levels of root inhibitors and have two cofactors that act together to enhance the rooting effect of auxin hormones. When juvenile cuttings become five to eight months old, those factors disappear and root inhibitors develop. Vieitez also suggests that etiolation (total exclusion of light) may help accelerate the formation of roots on cuttings, though this requires further testing in chestnut propagation systems (Vieitez, 1992).

Greg Miller experimented with root cuttings but had poor success. He attempted 10,000 cuttings, which resulted in 100 trees in the field, with only 10 trees remaining long-term. Not only was the success rate extremely low, but the cuttings that grew into trees didn't seem to fare any better than grafted trees in terms of survival and performance in his area (G. Miller & Revord, n.d.).

Tissue Culture

Tissue culture may become a more common chestnut propagation method in the future, though it currently remains more of a research tool than a practical method for most growers. This technique involves growing plants from small pieces of plant tissue in sterile laboratory conditions, allowing for rapid multiplication of selected genetics. There is currently one company, West Coast Chestnut, that sells cultivars propagated via tissue culture and is so far having the most success with European-Japanese cultivars. Complex hybrids and Chinese chestnuts seem to be more challenging to propagate via this method.

Many experts in the field are excited by the possibility of tissue culture because once refined, it addresses the fundamental problems of grafting. Like trees propagated from cuttings, tissue-cultured trees are genetically identical to the original throughout their entire structure. If the tree gets damaged or cut back to the ground, all regrowth maintains the intended genetics with no risk of rootstock overtaking the cultivar. Many people consider tissue culture the future