RUTGERS
New Jersey Agricultural Experiment Station

Thomas J. Molnar, Ph.D.
Associate Professor
Department of Plant Biology
180 Foran Hall
Rutgers, The State University of New Jersey
59 Dudley Road
New Brunswick, NJ 08901-8520 USA

aesop.rutgers.edu/~plantbiopath
molnar@aesop.rutgers.edu

Phone: 1-848-932-6330
Fax: 1-732-932-3844

Rutgers Hazelnut 2020: Brief Overview on Production, Orchard Design, Cultivars, Orchard Establishment

Thomas J. Molnar and John M. Capik
Plant Biology Dept. Rutgers University

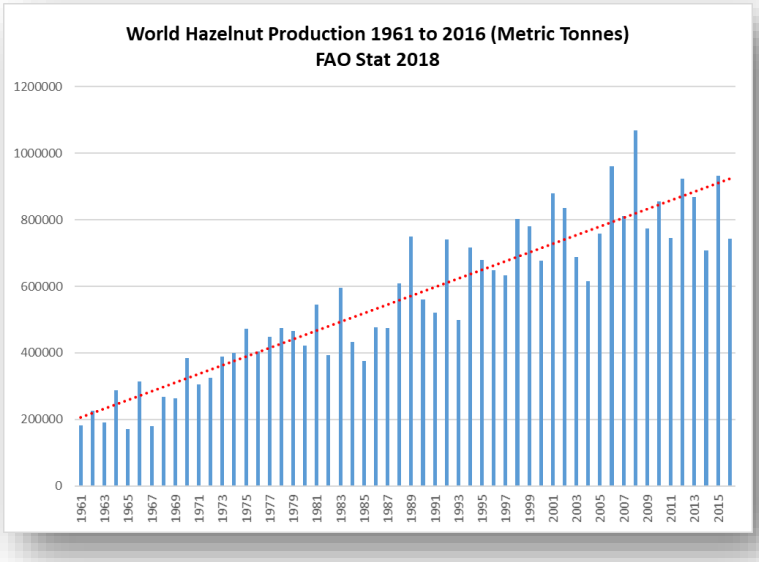
Background on hazelnuts (aka filberts):

Current production centers: Historically, the European hazelnut, *Corylus avellana*, has been grown commercially in regions of the world with Mediterranean-like climates that have mild summers and cool winters moderated by large bodies of water. Today, around 70% of the world's crop comes from the Black Sea slopes of Turkey, 15% from Italy, and 5% from the U.S. Smaller amounts are produced in Chile, France, Spain, Georgia, Azerbaijan, and China. Ninety-nine percent of the U.S. crop is grown in the Willamette Valley of Oregon.

World hazelnut market: The international hazelnut market is valued at about $3 billion per year, with total yearly world production averaging about 850,000 metric tonnes. Ninety-three percent of the crop is sold as kernels for confectionary and snack products, with the remaining sold as in-shell nuts for home cracking. Turkey dominates the world market, and their round, clean kernels set the standards for the confectionary industry. Production worldwide has increased steadily over the past 50 years. However, the bi-annual production tendency of the crop, which is quite pronounced in Turkey, affects the world wholesale price each year and prices paid to farmers can fluctuate between $0.80 to $2.00 per pound for in-shell nuts. Oregon historically produced large-sized nuts for the in-shell market, with much of their production exported to China. However, new plantings are cultivars for the blanched kernel market. It is important to note that **most hazelnuts consumed domestically are imported!** Demand for hazelnut products continues to rise, especially for products like Nutella® (Ferrero®), with supplies just barely meeting demand.

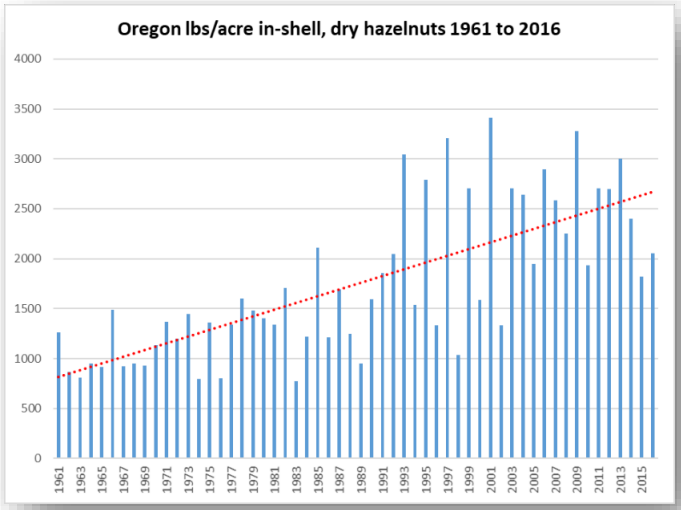
Turkish hazelnut, round and free of skin when roasted

Typical Oregon in-shell hazelnut ('Barcelona')



Production traits: Hazelnuts are considered to be a low-input, yet high-value crop. They can be grown on a variety of soil types (if well drained) and with limited pesticide applications, limited supplemental irrigation (in the northeastern U.S.), and minimal pruning once established. The crop is harvested mechanically (needs much less hand labor than other horticultural crops) and is stable and non-perishable once dried (can be stored for over 1 year and still maintain quality). **Follow the link below to read Oregon State University production guidelines and extension bulletins,** which have significant carryover for New Jersey and other parts of the eastern US. https://www.dropbox.com/sh/5g1vme2o3rycyie/AADd3_OuFuC-ZkxKzP2HYv6Fa?dl=0

Hazelnut yields: Hazelnut production in Oregon reaches some of the highest yields in the world. However, bi-annual bearing (alternating between high and low crops every other year) is still common. This is largely due to many of the orchards still being planted to the cultivar 'Barcelona', which has this genetic tendency. Newer cultivars combined with better management show less bi-annual production. With improved management, yields per acre have increased over the past 20 years in Oregon; the past 10-year average was **2,511 pounds nuts per acre.** "Down" years still remain close to 2,000 pounds. **Note: Trees begin to bear nuts at 3-4 years with significant production in years 7-8.**




Eastern filbert blight stem canker

Hazelnuts in the eastern U.S.: Attempts at hazelnut production have been made in the eastern U.S. since colonial times with no success. This failure is NOT necessarily climate related, as the Fruit Belt regions of the East, such as the Mid-Atlantic region, have soils, temperatures, and rainfall patterns quite amenable for hazelnut production. **The lack of success is largely related to a naturally occurring fungus, *Anisogramma anomala*,** that causes the disease eastern filbert blight (EFB) on hazelnuts.

EFB is found associated with the wild American hazelnut, *Corylus americana*, which has a wide native range across eastern North America. EFB causes little damage on the native species, but is devastating to the European hazelnut. Our

native hazelnut, which has tiny, non-commercial quality nuts, acts as a reservoir for the fungus to spread spores that infect the European hazelnut.

EFB in Oregon: For nearly 100 years, the EFB fungus was not found in Oregon or Washington, which allowed the industry to thrive. However, in the 1960s it was accidently introduced into Washington, where it nearly eliminated production. It spread south and has become a serious expense and management challenge in Oregon. Breeding efforts at Oregon State University led to the release of "resistant" cultivars about 10 years ago. They have been widely adopted and resulted in a significant expansion of acreage (the Oregon industry has expanded ~12,000 ha over the past 8 years). **Unfortunately, the new Oregon cultivars get EFB in New Jersey.** However, breeding advances in Oregon support work in the eastern US!

Rutgers Hazelnut Breeding Program: Rutgers has had an active hazelnut breeding program since 1996. The primary objective has been to identify resistance to the fungus that causes EFB. The approach included making large seed collections across Eastern Europe and the Caucuses to grow the trees in New Jersey. From these populations, about 2% were resistant. These plants and others from Oregon State have been incorporated into advanced breeding lines to develop commercial-quality cultivars for the eastern US.

Rutgers breeding nursery showing healthy trees and those dying from eastern filbert blight

Current status - New cultivar releases in 2020: The first cultivar releases from the Rutgers program are now available! Their names are **'Raritan', 'Monmouth', 'Hunterdon', and 'Somerset'.** They are propagated by micropropagation and are **available for sale from NJ-based Foggy Bottom Tree Farm** nursery (www.foggybottom.farm). Contact Don Knezick Don@foggybottom.farm or (609) 516-0780 for wholesale availability. See https://foggybottomhazelnuts.com/ for retail mail order sales. They were selected at Rutgers from offspring of parents crossed by Dr. Shawn Mehlenbacher for their high tolerance/resistance to EFB and round kernels that blanch well after roasting. **They are pure European hazelnut** and are **targeted for USDA Hardiness Zones 6-7** with testing in Zone 5. It is suggested to plant a mix of cultivars in the orchard to aid pollination and better manage EFB in the long term by reducing selection pressure for any single source of resistance**. 'OSU 541.147' (The Beast™ hybrid hazelnut)**, also available from Foggy Bottom, is recommended for planting in the orchard as a supplemental pollinizer along with hybrid hazelnut seedlings.

'Somerset' hazelnut: EFB-resistant and high-yielding with high-quality kernels

Preparing for orchard establishment: *Note: Below is a brief overview of the components to consider when growing hazelnuts. It should not be considered as a thorough examination, just a primer on various aspects of the crop*. Now is the time to begin preparations for those interested in planting the first commercial test orchards. While the clonal nut producing cultivars may have limited availability in 2020/2021, some pollinizers are available now and can be planted right away (as described later). Hazelnut is a new crop for the eastern US, and we are still developing best management practices for the region. Fortunately, we can borrow a lot of knowledge from Oregon and Italy. Using experiences gleaned from more traditional regions and our own efforts at Rutgers, we will work closely with new growers interested in helping us develop this new crop. *Below are some brief agronomic points to consider.*

Young hazelnut orchard showing clean strips in rows

1) Site selection: *We greatly prefer that the initial test orchards are established on the most appropriate lands*. This is to help develop a baseline for good tree growth, yields, and nut quality, and to get the early industry off to a great start. **Soils appropriate for peaches and apples are usually considered good for hazelnuts**, as is land that has shown success with other horticultural crops and grains. For the most promising results, **do not locate a hazelnut orchard where the soil is poorly drained** (hazelnuts cannot tolerate "wet feet"), shallow, too heavy, or too light, although irrigation, mulch, and increased fertility can augment the latter**. An orchard that is unproductive because of unsuitable soil is generally not profitable**. See notes on site selection in Oregon here: https://catalog.extension.oregonstate.edu/em9076

Table 2.—Nitrogen application rates for young hazelnut trees.

Age (year)	Apply this amount of N (lb/tree)
0–2	0
3–5	0.25–0.33
6–7	0.33–0.50
8–10	0.50–0.75

Nitrogen data from Oregon State Extension Service

2) pH and Fertility: Please do a soil test before planting. https://njaes.rutgers.edu/soil-testing-lab/how-to.php An ideal pH is 6.5, but a range of 5.8 to 7.0 is generally fine for hazelnuts. Consider fertility approaches from Oregon. See https://catalog.extension.oregonstate.edu/em9080

Rutgers hazelnut trial at harvest time

3) Weed control and mowing: Hazelnuts are shallow rooted and can suffer from weed competition. Weeds need to be controlled in the tree strips in the row (4-5' wide), typically with labeled herbicides including contact and pre-emergent chemistries (glyphosate, Surflan®, Goal®, etc.). Proper mulching is also a good option with multiple

benefits, especially in years prior to nut harvest from the orchard floor (vacuum harvester can suck up mulch). Be careful not to create rodent (vole) habitat. Roadways should be planted to grass or other cover to prevent erosion but be mowed regularly to reduce root zone competition.

Six-year-old orchard showing proper maintenance

4) Irrigation and new tree planting: Irrigation can be very beneficial to tree establishment during the early years, and for boosting kernel quality (kernel fill) during droughts in later years. However, it is not always a necessity for production in the eastern US depending on soil depth and quality. The best time of the year for tree planting is generally the fall (October) with well hardened stock, but spring planting is also possible if water is available. Soak trees in after planting to settle the soil and then, if possible, irrigate over the next 2 years during dry spells. Economics will dictate the need for irrigation in later years—trickle irrigation may be a useful addition and will be explored in research trials. **Regular irrigation will bring trees into bearing sooner, allow for better yields/quality in dry years, and reduce the tendency for bi-annual bearing**, but our experience shows hazelnuts can be grown without it on good soils (e.g., sandy loam or other well drained, deep soils with high soil organic matter) when proper weed control and mowing is practiced. Very sandy soils will likely need irrigation for success, especially once trees reach maturity and full, heavy crops are produced (year 7-8 from initiation).

Filbert worm, *Melissopus latiferreanus,* present in OR but not yet seen in NJ

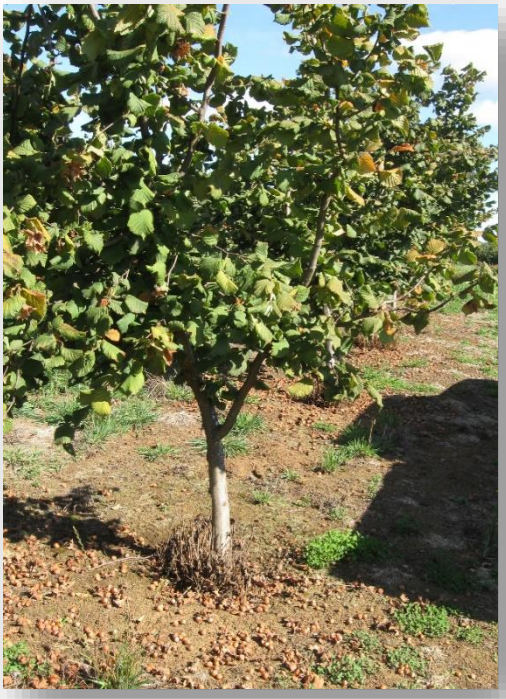
5) Pest and disease control: Besides EFB, hazelnuts suffer from few diseases of major concern. Some orchards may find bacterial blight is a problem in wet years, but this is typically sporadic and controllable with labeled copper sprays. No other diseases of economic impact are common for hazelnuts in the eastern U.S., and few insect and mites affect the crop above economic thresholds most years. Most hazelnut-specific pests from Oregon (filbert worm, filbert aphid) are not present in large numbers in the East. However, Japanese beetles can be a problem and require sprays if the numbers get very high. Brown marmorated stink bugs can also reduce kernel quality and may warrant control. Big bud mite, if present, can be controlled with dormant oil sprays at the proper time. Aphids and mites tend not to become a significant problem due to natural predators present when sprays are limited. With EFB-resistant cultivars, there are few routine or required chemical sprays for hazelnut, allowing the orchards to be hosts for a diversity of helpful arthropods and other organisms.

Bacterial blight (*Xanthomonas arboricola* pv. corylina) lesions on hazelnut husks

Warning! Rodents may be the biggest threat to your hazelnut crop…

6) Rodent control: Squirrels and chipmunks can **DEVASTATE** the crop. They eat the nuts directly from the trees in July before they are ready to be harvested and then can continue until the crop is gone. If not controlled, **they can eat literally 1,000s of pounds of nuts per acre.** Plant orchards as far from the woodline as possible and encourage hawks and other predators. Hunt, trap, etc. year round (check local laws) to reduce populations. Ground hogs, mice, rats, blue jays, racoons, bears, and turkeys also like to eat hazelnuts.

7) Pruning: Hazelnuts grow naturally as multi-stemmed bushes. However, to enhance early yields and ease of harvest, production trees are maintained on single stems which will require removing suckers from the base 2-3 times a year by hand or with labeled chemicals. In addition, during the first dormant season, select three to five major limbs to become the scaffold branches. Choose limbs that are evenly spaced around the tree trunk in different directions and have some vertical space between them (preferably at least 6 inches). Remove all of the other limbs. Very little pruning is necessary after the scaffold structure has been established. Once canopies close (10-12 years), systematic pruning needs to be done to open canopies to light (some growers may remove every other tree if on 10' in-row spacing).



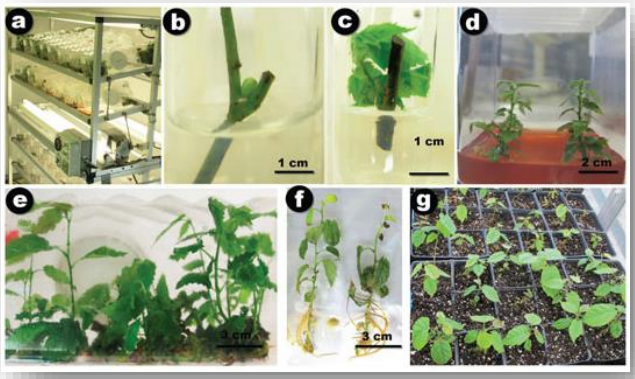
Note that the nuts drop to ground at harvest, as well as remnants of suckers at base of crown.

8) Deer Protection: For optimal results, including coming into bearing as soon as possible, trees need protection from deer. Farmland with a secure deer fence is the very best option. Deer will browse on new shoots, which slows growth, and bucks can cause major damage to stems with their antlers.

Typical buck rub that girdles hazelnut stems

Tree tubes can help protect stems from rub

Plastic garden fence can be cut into tubes 3-4' long and secured around the stem to deter buck rub. Once trees are over 6' tall, deer browse is less of a concern. However, deer can learn to eat nuts that fall to ground at harvest. Unfortunately, fencing to exclude deer is likely necessary for commercial-scale production in places like New Jersey with very high deer pressure. Note that deer also like to eat catkins.



Micropropagation of hazelnuts. A very effective way to multiply thousands of plants in short period of time

9) Plant material—pollinizers: Hazelnuts are a wind-pollinated (no bees needed), self-incompatible species. This means that they require unrelated sources of pollen, different incompatibility (S) alleles, to produce nuts, and some plants may not be able to inter-pollinate. Hazelnuts bloom in February and March in New Jersey. Interestingly, male (catkins) and female flowers open at different times of the year, depending on the winter temperatures. Consistent yearly production requires a series of early, mid, and late pollinizers so peak female bloom of the nut producing cultivar is not missed. Our fluctuating climate can also cause catkins on some trees to elongate too early and become damaged by sub-freezing temperatures. Fortunately, female flowers are very cold hardy and stay receptive for multiple weeks. If compatible pollen comes available at some point in the winter after female bloom, crops will be a success.

Female flowers (top) and male flowers (bottom)

To ensure consistently high yields, **our current recommendation is to grow a wide diversity of seed-propagated (not clonal) pollinizers in high density rows in the orchard** (border rows and every 6th row). Utilizing a diversity of seed-based pollinizers supports a wide range of bloom timing, S-alleles, and cold hardiness which should provide for consistent orchard pollination. *Note, seed-derived trees will be variable in traits including EFB resistance, nut yields, and kernel quality. They should be managed accordingly…* In addition, 'OSU 541.147' The Beast™ hybrid hazelnut is also recommended as a clonal pollinizer to intersperse across nut production rows in the orchard.

Example of seed-derived pollinizers distributed from Rutgers for early test trials.

10) Plant material—clonal nut producers: Hazelnut cultivars are propagated clonally like apples. However, they are not grafted but produced on their own roots. They usually cannot be rooted from stem cuttings, thus have been produced through mound layering or more recently by micropropagation (tissue culture). Today, nearly all hazelnut cultivars are propagated by this method, including much of the new orchards being planted in Oregon. **Unfortunately, the new cultivars developed in Oregon get EFB in the eastern U.S.**

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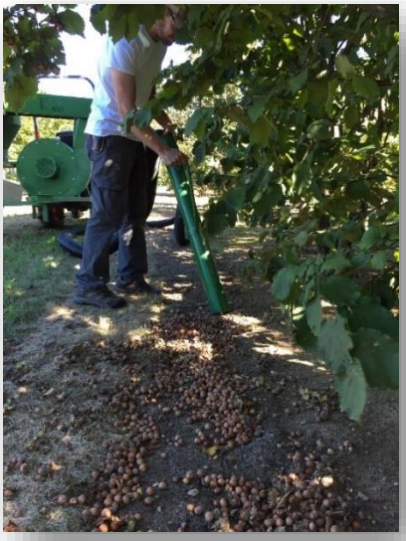


Harvesting at Rutgers with Italian-made Chianchia model K530 vacuum

New cultivars from Rutgers: Four cultivars were chosen for release based on nearly two decades of evaluation and replicated trials in New Jersey. Being the first releases of a new crop for our region, pilot scale (1-5 acres) orchard testing is suggested prior to larger-scale planting. Examples of **test orchards are detailed later in this document.** The new EFB-resistant cultivars, developed in collaboration with Oregon State University, produce high-quality, flavorful kernels that fit confectionary market needs and can be size-sorted and sold as in-shell nuts or made into value-added products.

High quality hazelnuts peel very easy after roasting…

Other cultivars or seedlings available? We collaborate very closely with Oregon State University and test plants from their program. While the Oregon cultivars such as 'Jefferson', 'Dorris', 'McDonald', and 'Yamhill' produce excellent quality nuts, they get too much EFB in our plots at Rutgers to recommend. They would need routine fungicide applications to survive, which some growers might consider acceptable. However, due to the expense of the chemical applications and uncertainty of long-term control in the east, we cannot advocate this approach.

'Yamhill' is widely planted in Oregon where is gets no EFB.

Fortunately, The Beast™ hybrid hazelnut ('OSU 541.147'), developed at OSU and released by the Hybrid Hazelnut Consortium, is EFB resistant and will pollinate the Rutgers plants in both directions and at the proper time, thus it is suggested as a pollinizer clone in the Mid Atlantic. Although it has smaller nuts, it is a high-yielding, vigorous, EFB-resistant tree that may also work as a production cultivar. Other possibilities include cultivars from Grimo Nut Nursery, namely 'Gene' and 'Slate', as examples of EFB-resistant selections we've evaluated. 'Gene' (S_{15}, S_{23}) will pollinate all 4 Rutgers cultivars and 'Slate' (S_1, S_{23}) will pollinate 'Raritan' and 'Somerset'. Both also work with 'OSU 541.147' (S_8, S_{23}). Note that their nut quality is not high enough to recommend them alone for large-scale commercial production. 'Grand Traverse' (S_{11}, S_{25}) will also work as a pollinizer: see Great Plains Nursery.

Hybrid hazelnuts? Currently, these are seed-propagated hazelnuts grown in Upper Midwest derived from crosses of our native hazelnut with the European hazelnut. The offspring are then allowed to openly pollinate each other and intercross over multiple generations. While EFB resistant and cold hardy, they are variable in most traits and generally have poor nut quality when compared cultivars of European hazelnuts. On average, kernels are very small, yields are low, and nuts do not drop to the ground for harvest. **New clonal breeding selections in development and under test by the Hybrid Hazelnut Consortium and the Upper Midwest Hazelnut Development Initiative hold significant potential.** In addition, due to their cold hardy catkins, seedlings and clones should prove very useful as pollinizers in the Mid-Atlantic region!

11) Harvest and cleaning nuts: European hazelnuts naturally drop their nuts to the ground in early September (no shaking required) and are harvested directly from the orchard floor. A variety of machines exist for harvest (available in Italy and Oregon). The simplest machine is an Italian vacuum-type device like pictured here. It is powered by the PTO on a tractor. However, much more sophisticated and efficient machines are available. For collection, nuts are generally blown into windrows (using backpack leaf blower, push-blowers, etc.) and then collected with the machine in a concentrated area. However, this option gathers a lot of other debris (as shown below), which must be then cleaned by another machine. More expensive, self-propelled harvesters may have cleaning stages included.

Harvester powered by Kubota narrow nursery tractor to fit down tight rows.

12) Drying, sorting… cracking: Once harvested and cleaned, hazelnuts need to be dried to around 6% moisture for consumption and long-term storage. This can be done on a small scale in a rain-proof area with good air circulation (onion sacks, stacked boxes with mesh bottoms, or on concrete floor in layers of 2-3 inches of nuts stirred regularly). Drying takes around 2 weeks depending on relative humidity and temperatures. For larger scale operations, heated dryers are used. Once dry, in-shell nuts can be stored at room temperatures (away from odors) for over a year and still maintain quality.

The Italian-made Chianchia 2-stage cleaning machine removes sticks, stones, shells, etc. and even blank nuts.

Rutgers hazelnuts were selected to have high-quality kernels that should yield premium prices for growers.

Nuts can be sold in-shell directly to consumers, but many buyers will be interested in kernels. We have not yet explored the food safety requirements needed to be in place at Rutgers for cracking kernels for sale, but this is a project for the near future. However, in preparation for shelling, in-shell nuts need to be sorted by size using round-hole sorters, ideally in 0.5 - 1.0 mm diameter increments. Various machines exist for this process that can be purchased, such as our Italian-made sorter and sheller from the Chianchia company. Once sorted, the nuts can be cracked by a variety of available devices, some of which also remove the shell pieces. Our small-farm device works quite well but may not meet all US food safety specifications. We can examine shelling machines used in Oregon to build our processing operations in the East.

In-shell nuts stored at Rutgers, dry and in large sacks at ambient indoor temperatures. Quality is stable for 1 year.

Nuts drying at Rutgers in greenhouse. Here they take about 2 weeks to complete drying at ambient temperatures.

Kernels: Hazelnuts have a long storage life when kept in the shell – one year at room temperature and two years in freezer. Dry, raw kernels kept in sealed containers in cold storage remain fresh for 6 months (longer in the freezer; however, they should be used soon after thawing). Roasted kernels and crushed or cut/sliced kernels have a shortened storage life; roasted nuts have the very best flavor when consumed within a week from roasting.

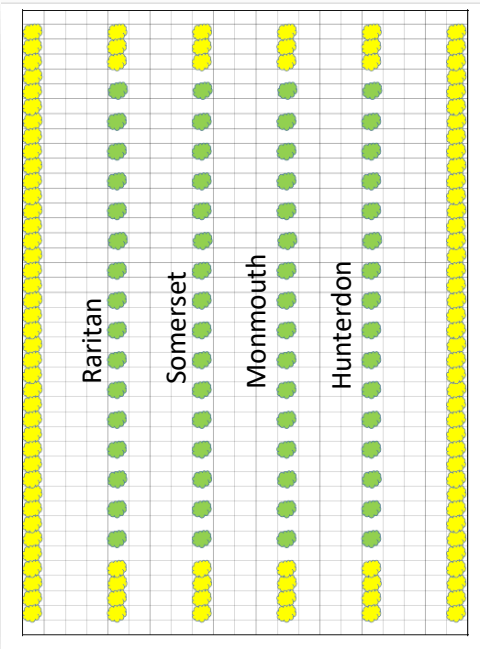
Italian-made size sorter and sheller at Rutgers (Chianchia P80 Super).

Roasted kernels of 'Monmouth' hazelnut prior to rubbing off skins.

Value added products: Substantial economic opportunities may exist for developing locally grown and produced, value-added hazelnut products. Most U.S. consumption is from imported nuts (we can change this!). Demand for hazelnuts are increasing worldwide, especially for products like nut butters (Nutella®), ice creams, and candies, but also for other end uses like healthy nut-based snacks, (consumption of tree nuts as a health food continues to rise—see heart healthy claims by FDA), nut milks, and culinary oils. Many options exist for value added product development. Examples include raw and dry roasted nuts, salted nuts, candied nuts, healthy nut butters, chocolate-hazelnuts spreads, ice cream/gelato, chocolate candies, chopped nuts for toppings, nut milks, and gourmet roasted hazelnut oil (consider also "organic" versions of each). Some farmers have experimented with finishing hogs on hazelnuts to enhance meat quality as a value-added component. We hope that our collaborators will come up with some new and exciting ways of utilizing their crops and let us know about it!

Establishing Hazelnut Test Orchards: There are two components to the test orchards – clonal nut producing cultivars and pollinizers. Here we describe plans for initiating **small test trials that will require approximately 1/2 acre**. One-acre size orchards will have a similar design, just expanded. Larger plots will follow similar design with borders and **every 6th row as a pollinizer row.** Note the pollinizers suggested in these designs are from germinated seed (not clones). Adding clonal pollinizers such as 'OSU 541.147' is shown in the diagram on the next page.

Example: plot of land 100' wide x 200' long (20,000 sq. feet)



- Spacing between rows is 20 feet **(6 total rows)**. 18 feet between rows works well too.
- The outer rows of the trial are planted to pollinizer seedlings (yellow trees in diagram) spaced at 5 feet apart within the row. This would be around 100 trees per appx. 1/2 acre (start each row with 3-4 seedlings; more pollen = more consistent nut production).
- The 4 interior rows of the plot will hold the clonal nut producing trees (green trees on diagram). **These are spaced 10' apart in the row**. This would be 64 trees (16 per row) for such a plot: four cultivars, one row each. Trees would be planted in a systematic design to aid data collection and evaluation. Plot sizes can vary but spacing should be kept similar. Rows can be spaced 18' apart and clonal trees spaced 12' apart to gain a little more time before having to cut trees or prune heavy. 10' between trees is considered high density and some trees will need to be removed around year 10 based on practices in Oregon.

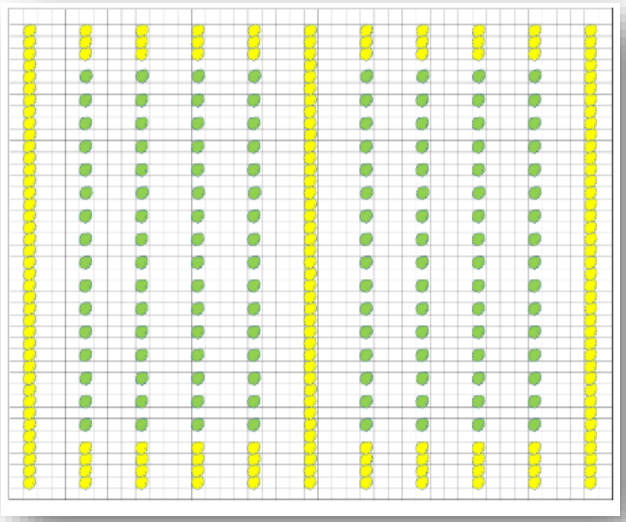


Diagram of 200' x 200' field layout

Example of 1-year old test orchard

Adding 'OSU 541.147' The Beast™ hybrid hazelnut as clonal pollinizer in the test orchard

Expandable design has pollinizers every 6th row. The idea is to not be more than 60' from a pollen source based on research in Oregon. In this example, every sixth row is a dedicated pollinizer row. Each block on the grid is 5' square. Yellow tree = pollinizer seedling, green tree = clonal nut producer row. Suggested here is alternating rows of 'Raritan', 'Monmouth', 'Hunterdon', and 'Somerset'. **Red dots are 'OSU 541.147' The Beast™** hybrid hazelnut interspersed as pollinizer throughout the orchard. If desired, growers can use a size sorter to separate the smaller 'OSU 541.147' nuts at harvest. Other orchard designs are possible including growing single cultivars in larger blocks and blocks of 'OSU 541.147', which is high yielding and may be better adapted to poorer site conditions and USDA hardiness Zone 5. **With any design, it is critical to keep the pollen cloud in mind: S-alleles, bloom timing, and cold hardiness of catkins!**

Other plot considerations for best results:

- **Weeds should be controlled** in the tree strips in the row (4-5' wide) as discussed earlier in the document.
- **Grass must be mowed regularly** within the plot - short grass and few weeds help conserve moisture and fertility for the trees.

- **Young trees need to be irrigated** when dry to keep active growth– if it's not possible to irrigate, all planting is to be done in October/November with dormant stock. The first 2-3 years are very important to get good root growth and support nuts being produced in year 4 onward. Mulch can help to conserve soil moisture.
- **Trees need protection from deer** - especially the clonal trees that will be pruned to a single stem. Seedling pollinizers can take some deer browse, but it slows down growth greatly and will take longer for them to come into production and produce pollen. Some growers will use individual metal fences around each tree to protect them when the entire farm/plot is not protected by a larger deer fence.
- **We highly recommend soil tests** to be done on your plot. Rutgers has a soil testing lab which can do the necessary analyses (https://njaes.rutgers.edu/soil-testing-lab/how-to.php), although you are welcome to have it done elsewhere. Your county extension agent can help design a fertility plan based on the results.
    - https://njaes.rutgers.edu/county/

Thanks from the Rutgers Hazelnut team: Emil Milan (left), Tom Molnar (middle), and John Capik (right)

Other notes:

- **Pollination:** With the exception of 'Hunterdon', the Rutgers cultivars will pollinate each other, but we found that catkins can be frost damaged in some years (female flowers and vegetative buds are very cold hardy). As noted, we are strongly recommending to supplement these first orchards with a high density of seed-propagated and clonal pollinizers (OSU 541.147 or Slate, Gene, and Grand Traverse) to ensure a very large pollen cloud. Research around the world has shown pollen to be a limiting factor in regions new to production (i.e., Chile, New Zealand, and Australia), especially when trees are young (old trees produce many catkins and alleviate some of the issues…).
- **The seed-propagated pollinizer trees will produce nuts, but they will vary in size and shape (and yield).** They will generally all taste good when roasted (good hazelnut flavor is fairly standard). They might be fine mixing with cultivar trees but that depends on the end product goals, as the 4 cultivars will have much better roasting attributes and are much more uniform in quality. If used for other products (crushed nuts, butters, oils, etc.), there will be little difference in utility as long as they can be separated by size. By establishing pollinizer rows in the orchards, it should be possible to blow the clonal nuts into rows away from the pollinizer trees to keep them separate at harvest if desired. **'OSU 541.147' looks to be a great EFB-resistant pollinizer match for the Rutgers cultivars, and it is high yielding.** It has smaller nuts that should be easy to separate out with a size sorter, so it can be interspersed in the orchard to bolster the pollen cloud.

- **Check with Foggy Bottom Tree Farm for availability of seedling pollinizer trees sourced from Rutgers.** The Rutgers pollinizer trees are from select seed strains from our program that should prove cold hardy and EFB-resistant, but supplies may be limited. Other eastern sources of pollinizers include Z's Nutty Ridge (https://znutty.com/ cold hardy hybrid hazelnut seedlings and clones) and Grimo Nut Nursery (www.grimonut.com/ variety of seedlings and clones). See field layout above for pollinizer layout and numbers of trees per acre.
- **Of great importance** – The new Rutgers cultivars are pure European hazelnuts (not hybrids) developed in collaboration with Oregon State University. They were selected at Rutgers from crosses of high quality Oregon State University germplasm and are targeted for the U.S. **Mid-Atlantic region (USDA hardiness Zones 6 and 7)**. This is a new endeavor for this region, and your farms and your assessments will help to identify the best cultivars for production as well as best management practices. We have an ongoing breeding program and collaboration with Oregon State University and the Hybrid Hazelnut Consortium with **additional cultivars in the pipeline**. We will need your help in evaluating these four new cultivars and future cultivars for yields, tree health, quality of nuts, etc. What we learn from your trials will help shape the future of hazelnut breeding at Rutgers and will also inform our collaborators. Members of our team and your local extension agents may like to visit your farms in upcoming years as trees come into maturity to get your input on how the plants are performing. We have been working on this project for more than two decades and these test plantings represent a big step towards helping to establish a successful hazelnut industry in the eastern U.S.

2020 Rutgers Landmark™ Hazelnut series releases

Trees are now available from Foggy Bottom Tree Farm. Contact Don Knezick Don@foggybottom.farm www.foggybottom.farm More than two decades of research and breeding at Rutgers in collaboration with Oregon State University supports their release. However, long-lived hazelnut orchards need a sustainable and durable approach for disease management…

- Two methodologies were used to develop the new cultivars:
  - Horizontal Resistance
    - multi-genic resistance, highly tolerant
  - Vertical Resistance
    - single gene, resistant, sourced from Spanish cultivar 'Ratoli'

More in depth: The pathogen that causes EFB is genetically diverse in the eastern U.S., unlike in Oregon where it is uniform. Disease management strategies must take this into consideration. Horizontal resistance, also called quantitative resistance, concentrates multiple genes for high tolerance, which reduces the chance that the fungus can overcome the resistance over time. Tolerance is not immunity; under high disease pressure, trees can develop small cankers, but they have little to no impact on production and frequently don't even reproduce (no spread of spores). Vertical resistance relies on a single gene that provides complete protection from infection. It can be very effective, but overuse can lead to fungal evolution to overcome resistance. Using both methodologies and multiple sources of resistance in the same orchard should provide longevity.

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School of Environmental and Biological Sciences

Introducing the Rutgers Landmark™ Hazelnut Series

‘Raritan’ Hazelnut

Blanched kernel market type
Quantitative EFB resistance
S alleles 3, 22
Mid-season bloom
Vigorous, upright tree, high yield

Roasted kernels of 'Raritan' hazelnut

- Round kernels,
  most 12-14 mm in diameter
- Kernel weight avg.: 1.14 grams
- Kernel percent avg.: 47.7%
- Blanch avg. - 2.3/7.0 (1 = best)
- Nuts fall free of husk at maturity
- Very high level of tolerance to EFB (little to no cankers formed under high disease pressure; most lack stromata)

Parents: OSU 539.031 x OSU 616.018

Nuts, raw kernels, and roasted kernels of ‘Raritan’ hazelnut

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‘Monmouth’ Hazelnut

Blanched kernel market type
Quantitative EFB resistance
S alleles 1, 12; Early to mid-season bloom
Moderately vigorous, slightly spreading, high yield

Roasted kernels of 'Monmouth' hazelnut

- Round kernels, most 12-14 mm in diameter
- Kernel weight avg.: 1.19 grams
- Kernel percent avg.: 51.8%
- Blanch avg. - 1.3/7.0 (1 = best)
- Nuts fall free of husk at maturity
- Very high level of tolerance to EFB (few cankers formed under high disease pressure; most lack stromata)

Parents: ‘Sacajawea’ x OSU 616.055

Nuts, raw kernels, and roasted kernels of 'Monmouth' hazelnut

‘Hunterdon’ Hazelnut

Blanched kernel market type
Quantitative EFB resistance
S alleles 1, 3; Early to mid-season bloom
Vigorous, upright tree, high yield

Roasted kernels of ‘Hunterdon’ hazelnut

- Round kernels, some slightly oblong, most 12-14 mm dia.
- Kernel weight avg.: 1.23 grams
- Kernel percent avg.: 45.9%
- Blanch avg. - 1.0/7.0 (1 = best); **excellent blanching and flavor**
- Nuts fall free of husk at maturity; very early maturity
- High level of tolerance to EFB (few cankers formed under high disease pressure)

Parents: ‘Sacajawea’ x OSU 616.055

Nuts, raw kernels, and roasted kernels of ‘Hunterdon’ hazelnut

‘Somerset’ Hazelnut

Blanched kernel market type
Single gene EFB resistance from ‘Ratoli’
S alleles 3,10; Early to mid-season bloom
Compact tree, slightly spreading, high yield

Roasted kernels of ‘Somerset’ hazelnut

- Round kernels, most 12-13 mm in diameter
- Kernel weight avg.: 1.14 grams
- Kernel percent avg.: 54.9%
- Blanch avg. - 3.5/7.0 (1 = best)
- Nuts fall free of husk at maturity; early maturity
- Single gene resistance = free of EFB

Parents: OSU 665.123 x ‘Ratoli’

Nuts, raw kernels, and roasted kernels of ‘Somerset’ hazelnut

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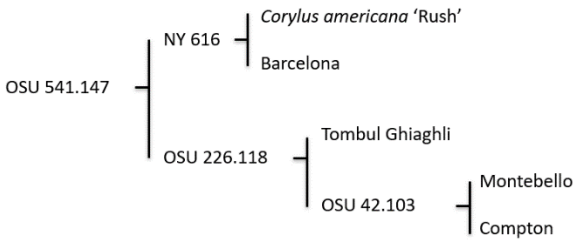
HYBRID HAZELNUT CONSORTIUM

‘OSU 541.147’ The Beast™ Hybrid hazelnut

Blanched kernel market type
Single gene EFB resistance from *Corylus americana* ‘Rush’
S alleles 8, 23; Early to mid-season bloom
Upright, vigorous tree with high yield
Released by Hybrid Hazelnut Consortium

Pedigree



- Round kernels, most 9-10 mm in diameter
- Kernel weight avg.: 0.9 grams in NJ (1.14 in OR)
- Kernel percent avg.: 44.2%
- Blanch avg.: 4.5/7.0 (1 = best)
- Nuts fall free of husk at maturity
- Single gene resistance = free of EFB (different gene than ‘Somerset’)
- **Recommended as pollenizer for ‘Raritan’, ‘Monmouth’, ‘Hunterdon’, and ‘Somerset’ in USDA zone 6a-7b**

Pictures courtesy of S. Mehlenbacher, Oregon State University

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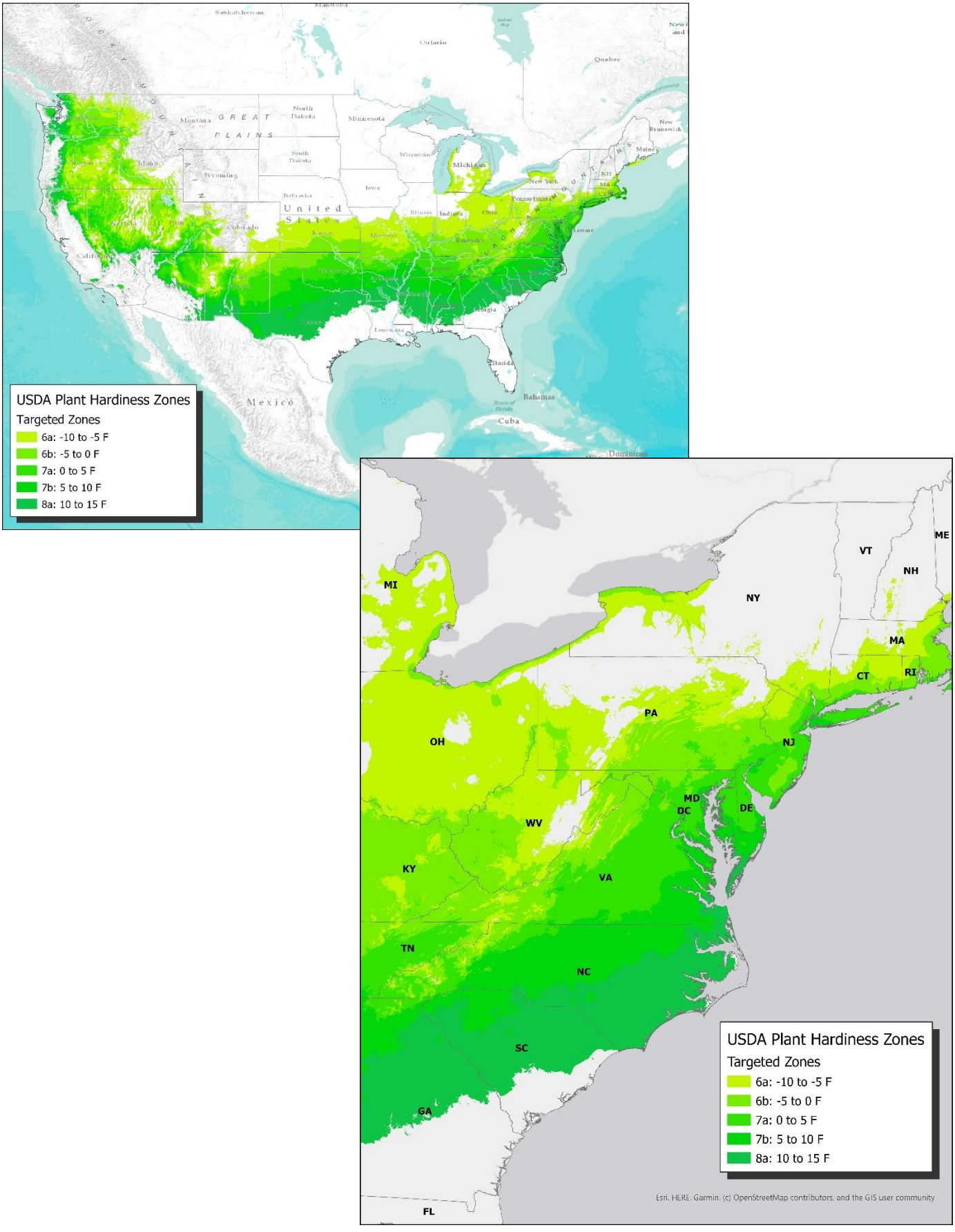
[USDA Plant Hardiness Zones](#) 6a to 8a



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