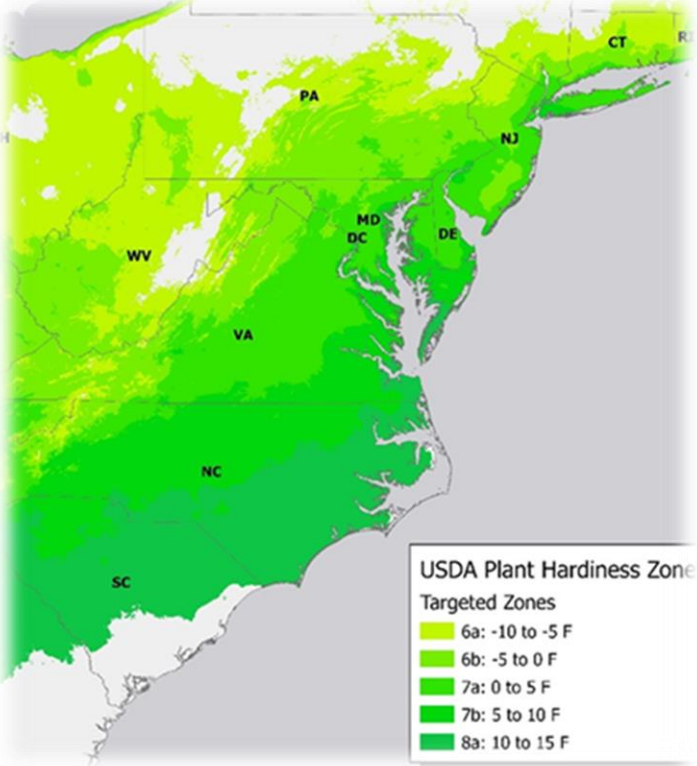

An Update on New Cultivars from Rutgers University

HYBRID HAZELNUT CONSORTIUM

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Hazelnuts in the United States

- 99% of U.S. hazelnut crop is grown in the Willamette Valley of Oregon
  - production acreage continues to expand supported by research and breeding at Oregon State University
    - Cvs. Yamhill, Jefferson, McDonald, etc.
- There is also a significant desire to grow hazelnuts in the eastern US
  - **unfortunately, OSU cultivars can die from some eastern EFB strains**
- Rutgers program started in 1996 to develop locally adapted, EFB-resistant **European hazelnut** cultivars
  - *Corylus avellana*

Tom Molnar and
Dr. Reed Funk (2000)

Rutgers University,
New Jersey, USA
Since 1996

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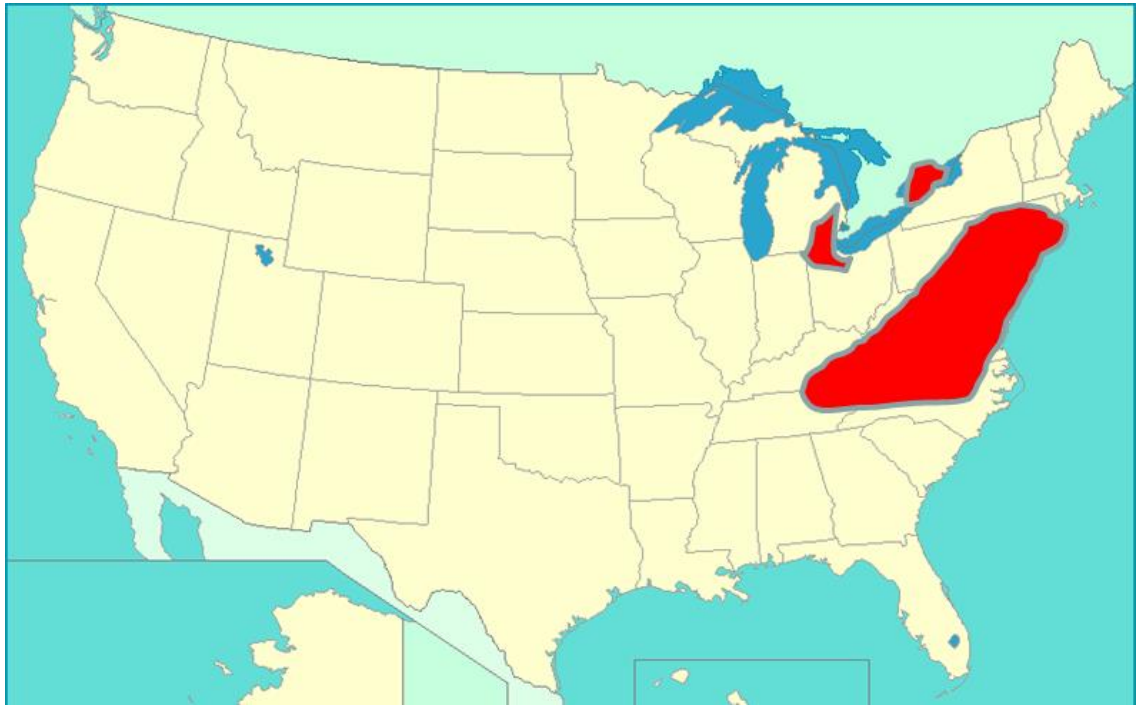
European hazelnut (*Corylus avellana*) is adapted to "Fruit Belt" of northeastern North America

- "Fruit belt" includes parts of the Mid-Atlantic and Great Lakes regions
  - Temperate climate with moderately cold winters and wet, humid hot summers (USDA Zone 6 and 7)
- European hazelnuts can grow well in this region <u>if Eastern Filbert Blight resistant</u>
- <u>Main premise at Rutgers</u>: Identify resistance in European hazelnut then breed locally adapted, commercial quality cultivars



Approximate "Fruit Belt" region of northeastern USA and southern Canada

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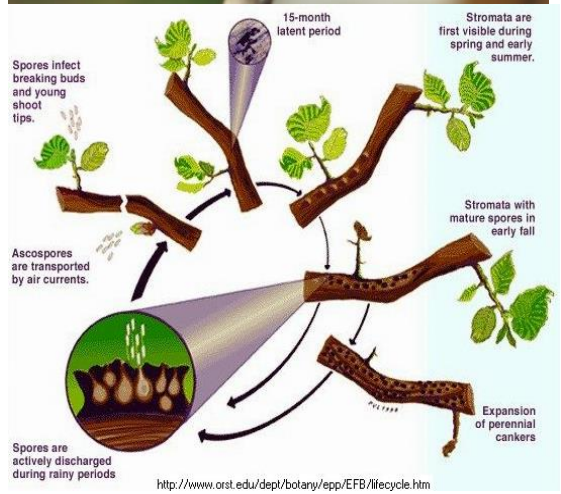
Eastern Filbert Blight is main limiting factor of production

Widespread in New Jersey – devastating to most European hazelnuts!



European hazelnut seedlings dying from EFB caused by *Anisogramma anomala*

https://web.engr.oregonstate.edu/~mendelse/EFB/index.htm

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Finding resistance to EFB in European hazelnut…

- Collaborating with Oregon State University we screened:
  - 1000s of seedlings from controlled crosses and foreign germplasm introductions (seed collections)
  - OSU cultivars and breeding selections
- Early on, most trees died from EFB…
  - **But we eventually found many sources of resistance!**
  - **>100 sources**

Locations of germplasm collection; Seeds seeds shared between Rutgers and OSU

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Rutgers Breeding Program

- **Main breeding objectives**
  - EFB-resistance (diverse and durable sources of resistance = *long lived resistance*)
  - Adaptation to eastern US (cold hardy catkins)
  - high quality kernels for the confectionary market
  - High consistent yields
- **Large breeding effort**
  - Controlled crosses made yearly
    - Plant 8,000+ trees per year from seeds from Rutgers and OSU crosses (Thank you OSU!). **High selective pressure**
  - Currently, over 30,000 trees in field
  - Large replicated evaluation trials
  - **More than 20 years of effort!**

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Finally, four cultivars released from Rutgers in 2020 (and one from Hybrid Hazelnut Consortium)

- EFB-resistant European hazelnut cultivars
  - ‘Raritan’, ‘Monmouth’, ‘Hunterdon’, and ‘Somerset’
- Hybrid *C. americana* x *C. avellana* from Hybrid Hazelnut Consortium
  - ‘OSU 541.147’ “The Beast”
- Trees now available from several nurseries!

Nut clusters, nuts, and kernels of ‘Somerset’ hazelnut

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‘Raritan’ hazelnut

Cross made in 2004 at OSU
Parents:
OSU 539.031 x OSU 616.018

- Blanched kernel market
- **Quantitative EFB resistance** (high tolerance) from Tonda di Giffoni and Sant Pere
- **S alleles 3, 22**
- Vigorous, upright tree
- Highest yielding in our trials
  - Mature trees >40 lbs dry in shell nuts per tree

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‘Raritan’ distinguishing traits

- Vigorous, upright growth habit
  - largest mature tree of group; vigorous trees are robust and easy to grow. Nice shape for orchard maintenance and harvesting
- Very high level of EFB tolerance
  - cankers seldom observed and few or no stromata
- Nuts drop clean from husk in mid-September
- Very good blanching after roasting
- **Doing well in propagation by Tissue Culture**

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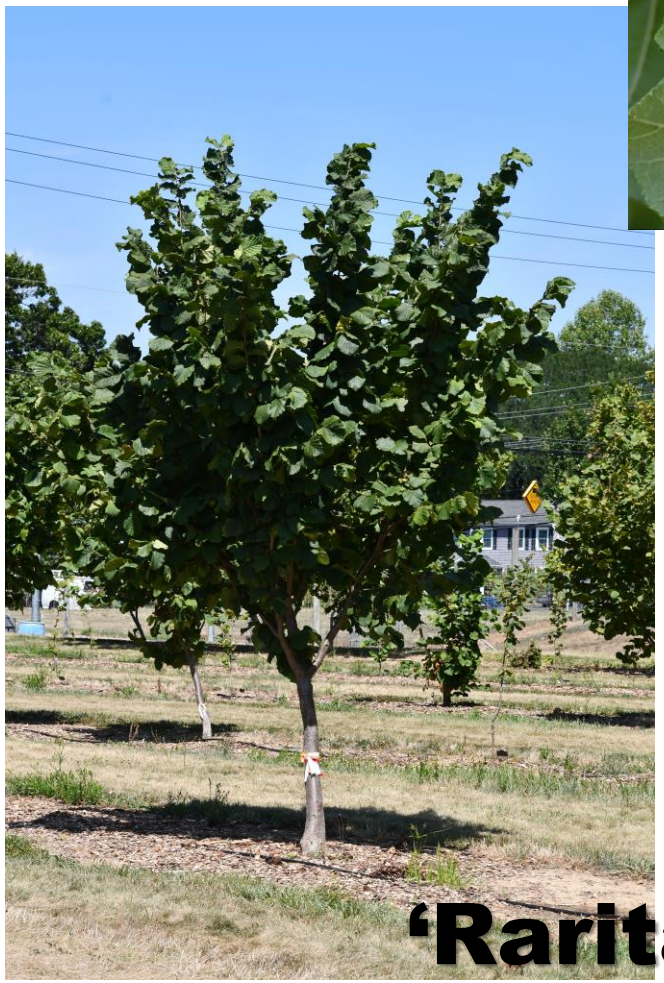

‘Raritan’ hazelnut

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‘Raritan’ is a large tree

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‘Raritan’ – 8 years and 6 years in field

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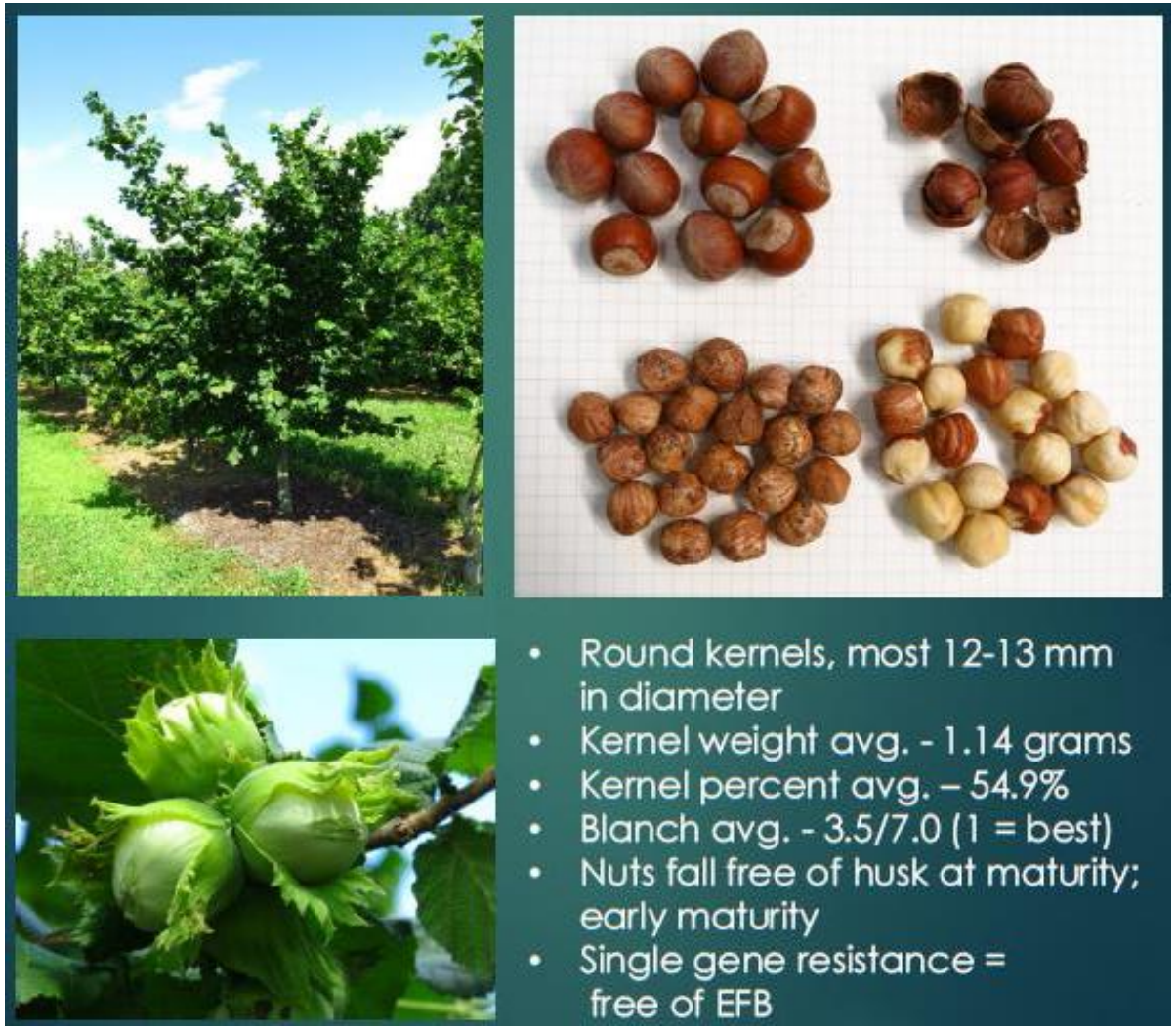
‘Somerset’ hazelnut



Cross made in 2000 at OSU
Parents: OSU 665.123 x ‘Ratoli’

- Blanched kernel market
- ‘Ratoli’ gene for resistance to EFB
- **S alleles 3, 10**
- Semi-vigorous, compact growth habit

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‘Somerset’ distinguishing traits

- Compact growth habit
  - Small statured tree compared to others. May find place in higher density orchards
  - Precocious (bears heavy as young tree)
- Very thin shells and round kernels
- Free of EFB in our trials
  - ‘Ratoli’ single gene resistance
  - On same linkage group as ‘Rush’ resistance, different than ‘Gasaway’

‘Somerset’

- Very precocious and can be **very high yielding**
- Slower growing than ‘Raritan’ and appears to need more inputs to support heavy crops on small trees
  - Water
  - Weed control
  - Fertility (foliar fertility)
  - Copper sprays for bacterial blight

‘Somerset’ at 5 years

‘Hunterdon’ hazelnut

Cross made in 2004 at OSU
Parents: ‘Sacajawea’ x OSU 616.055

- Blanched kernel market
- Quantitative EFB resistance
- **S alleles 1, 3**
- Moderately vigorous upright tree
- Very early maturing

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‘Hunterdon’ distinguishing traits

- Vigorous growth habit
  - more spreading than ‘Raritan’ and slightly more vigorous than ‘Monmouth’
- Early maturing
  - Nuts fall in mid-August in New Jersey
- Excellent blanching after roasting
  - Best flavor in taste tests at Rutgers
  - ***BUT YIELDS in our long term trials disappointing***

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‘Monmouth’ hazelnut

Cross made in 2004 at OSU
Parents: ‘Sacajawea’ x OSU 616.055

- Blanched kernel market
- Quantitative EFB resistance
- **S alleles 1, 12**
- Moderately vigorous upright tree
- Very good blanching, thin shells

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‘Monmouth’ distinguishing traits

- Moderately vigorous growth habit
  - more spreading than ‘Raritan’
- Accepts pollen from other 4 cultivars (S_1, S_{12})
- Very high level of EFB tolerance
  - cankers seldom observed and few or no stromata
- Thin shells and very good blanching after roasting
- **Not in TC production**
- **Yields are lower than Raritan and Somerset**

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‘Monmouth’ (6 years)

Monmouth vs. Raritan at 6 years

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‘OSU 541.157’ The Beast™ hybrid hazelnut

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OSU Oregon State UNIVERSITY

- Developed at OSU from a cross in 1990 using F_1 hybrid NY 616
- Tested at Rutgers since 2000 then Nebraska
- Released by Hybrid Hazelnut Consortium in 2020

Pictures courtesy of Oregon State University

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‘OSU 541.147’ “The Beast”

- Nicknamed “The Beast” as it was the most vigorous and productive plant in the early Rutgers trials
  - Held up to EFB inoculations from fungus collected across US
- Excellent pollinizer for ‘Raritan’, ‘Monmouth’, ‘Hunterdon’, and ‘Somerset’ in eastern US “Fruit Belt” region
  - S alleles 8, 23; Early to mid-season bloom
  - Now widely available; main clonal pollinizer

“The Beast” August 2022
19 year old tree
Hort Farm 3, Rutgers Univ. NJ USA

“The Beast” raw kernels have a lot of fiber on them but it flakes off after roasting

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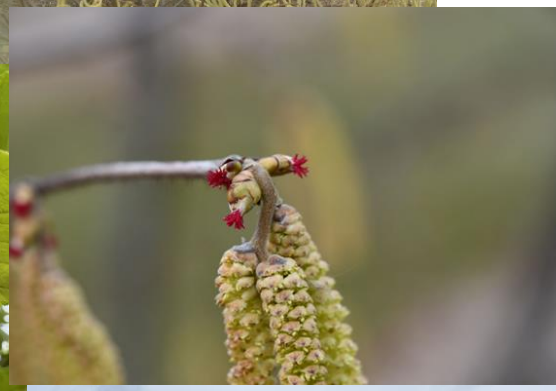
Breeding at Rutgers: new cultivars in the pipeline!

- Wider diversity of EFB resistance genes to support longevity of resistance
- Compatible S-alleles and varied bloom times (early, mid, and late)
  - Pollen availability critical concern for eastern US orchards…
- Consistent high yields with improved kernel quality



Rutgers Hort. Farm 3 Yield Trial

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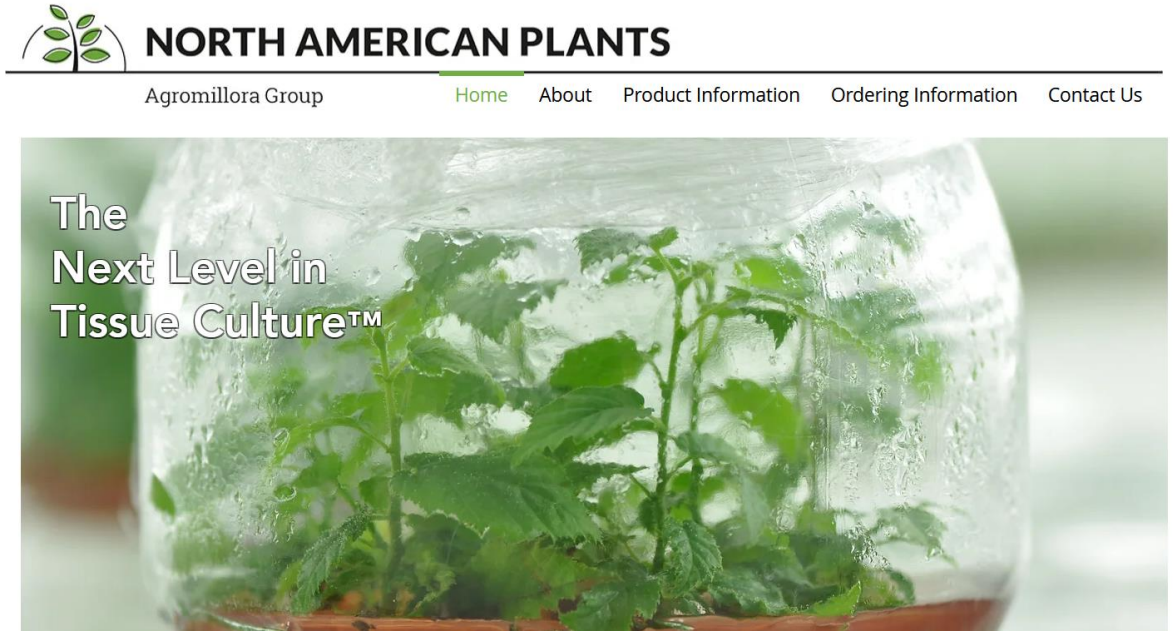
Propagation…

- Current cultivars produced primarily through **tissue culture** by North American Plants in Oregon – licensed propagator
  - Small amount also from Knight Hollow Nursery in Wisc.
- Then sold to grow on nurseries, primarily Foggy Bottom tree farm in New Jersey, but also nurseries in other regions
  - Foggy Bottom licensed propagator also rooting cuttings and grafting
- To date, ~100 acres have been planted
  - 10,000 trees sold each in 2021 and 2022
  - ~20,000 in 2023!



Grower of Rutgers University Landmark Series Hazelnuts

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Propagation: grafting…

- TC takes time to establish for a new clone and can have roadblocks/failures
- **Grafting presents an option to ramp up numbers of the new cultivars**
  - Raritan, “The Beast”, and Grand Traverse hazelnut from TC being used as rootstocks
  - EFB resistant, vigorous and with reduced suckering
- **Hot callus pipe method very effective**

Dormant trees (new varieties) with graft unions laid on hot callus pipe ~24 degreed Celsius
Greenhouse temp ~4 degrees Celsius; 8 weeks for callusing (5-10 January 2023)

High success rate (over 95%) and rapid growth (24 April 2023)

Trees of new cultivars will be used in pollinizer rows in orchards (test new cultivars and supplement pollen in Raritan/Somerset orchards)

Grafted trees are vigorous and can be field ready the same year as grafting…

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Propagation: mound layering…

Labor intensive but predictable and effective

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Rooting cuttings of TC stock plants

- Most hazelnut cuttings are challenging to root but juvenile suckers from TC propagated plants can root with reasonable success
- Licensed propagators can grow plants from TC (Raritan, Somerset, The Beast) and then root crown suckers
  - Presents another option for multiplying plants
- Bonus: grafted trees produce sprouts below graft union that can be harvested and rooted the year of grafting

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‘Raritan’ softwood cuttings in July from TC “rootstocks”

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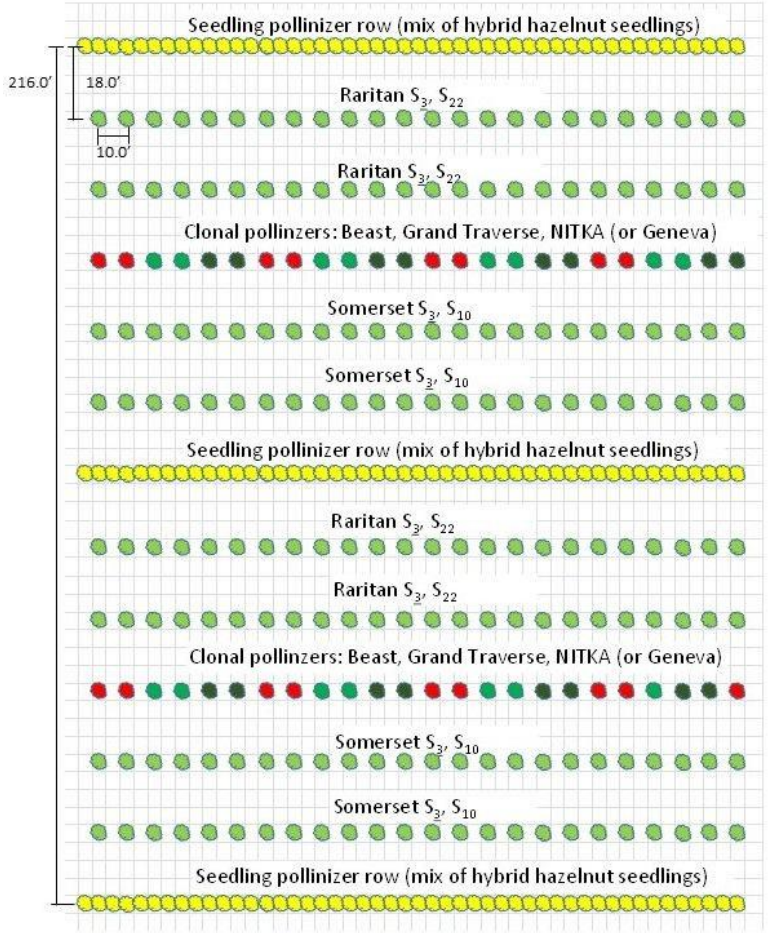
Conclusion: multiple propagation approaches are needed to diversify and meet demand for plants

- Orchards planted with diverse, pollen compatible cultivars can buffer climate variations– ***today, propagation is limiting factor***
- TC has its challenges and only a small number of cultivars are available; numbers still limited
- Diversifying propagation approaches across wider locations can help meet local demand
  - Support local production: many small nurseries vs. one large nurseries
  - Reduce shipping costs = sell larger trees better suited for orchard planting



Future looks bright for eastern US hazelnut production!

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Hybrid Hazelnut Consortium partners:

OSU Oregon State University

University of Nebraska Lincoln

Arbor Day Foundation

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