HYBRID HAZELNUTS

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This publication is intended to be a short introduction to growing hybrid hazelnuts. Virtually all plantings in the Upper Midwest are best described as research plantings. Ranging from conservation plantings to orchard plantings in old cow lots, the situations and circumstances are as diverse as the growers. Much of the information is based on the experiences of the authors, as well as first hand accounts and interviews with other current growers. This is not intended to be a comprehensive guide to hybrid hazelnuts but, instead, to act as an introduction.

Hybrid Hazelnuts

Hybrid hazelnuts are crosses between the European hazelnut *Corylus avellana*, which was bred for large nut size and which is the basis for the commercial hazelnut industry in the Willamette Valley of Oregon and Washington, and two native American species, *Corylus americana and Corylus cornuta*, the American and beaked hazelnuts respectively, that bring winter hardiness and disease tolerance to the mix.

Hybrid Hazelnuts do not have the large nut size of the European Hazelnut

Unlike the European hazelnuts, these hybrids are grown as multi-stemmed bushes, not as trees. This is important because it reduces their maintenance costs at the same time as increasing their ecological value to the landscape. These contributions include reduced soil erosion, improved water quality, improved wildlife habitat, and reduced inputs. In addition, they provide a favorable economic return to the farm family. Although still in their infancy as a commercial crop, hybrid hazelnuts have huge potential and are likely to play an important role in diversifying the landscape of the Upper Midwest.

American and beaked hazelnuts have an extensive native range, from Canada to Missouri and from the Ohio River Valley to Nebraska. Hybrid hazelnuts can be grown in many situations for a variety of reasons. Multi-functional conservation plantings such as living snowfences, riparian buffers, field windbreaks and shelterbelts provide significant ecological benefits, all while producing a crop. Because they do not require annual tillage, and because they may be grown with perennial cover between rows, hazelnuts are an ideal crop for highly erodible land. All of these situations provide much needed habitat for wildlife and increase diversity on the landscape as well as providing an economic return.

Uses/Markets/Commercialization

In early spring the male catkins begin to elongate to shed pollen

Photo courtesy of Roy Cerling

Currently only 20% of the hazelnuts consumed in the United States are produced in this country, so there is a large un-met market demand, which is likely to grow as new hazelnut products are developed. American consumers are most familiar with hazels as a component of gourmet party nut mixes, coffee flavoring, and in decadent chocolates, but they can also be used for cooking oil, massage oil, cosmetics, sandwich spreads similar to peanut butter, and milk substitutes. Demand is projected to grow as we become more aware of the health benefits of eating nuts: they are high in vitamins E and B-6, and in monounsaturated fatty acids, which help reduce the risk for heart disease, as well as in several phytochemicals that protect against cancer.

Hazelnuts also have potential as a bioenergy crop: with an oil content of 60%, low energetic costs of production, and a high value animal feed co-product, hazels could rival soybeans for energy produced per acre. Several current producers are growing hazelnuts for that specific purpose. They hope to produce enough oil to fuel the farm as well as provide feed to livestock for gourmet meat.

Hybrid hazelnuts have market potential but it is currently undeveloped in the Midwest. Their initial market is likely to be in oil and other processed products, because hybrids do not produce the large nuts favored for the in-shell market or for fancy nut mixes. This means that value-added processing will be required. Currently there are no commercial processors in the Midwest, but that is likely to change, however, as more people start growing them and attracting investments in processing facilities. Cooperative development of these facilities is the most promising approach.

Efforts are currently underway to commercialize hybrid hazelnuts as a 3rd crop in the Upper Midwest. To be widely adopted plants must be relatively uniform, machine plantable & harvestable, as well as have favorable nut characteristics. To achieve these goals research is focusing on four areas: agronomics, industry infrastructure, genetics & propagation, and harvesting & value-added processing. In addition, several growers groups are organizing to facilitate education, research and development, promotion, and to be a resource for new and existing growers.

Establishment

Site Selection

Hybrid hazelnuts may be grown on marginal ground not conducive to row-crop production, such as sites with poor soil, highly erodible slopes, or poor drainage. They have done well in soils ranging from heavy clay to sand, with pH from 5.0 to 7.5 and higher. Once established, they are capable of withstanding both drought and standing water. However, they will perform the best on deep fertile soil, and where attention can be given to their care. Targeting hazels to marginal lands, which are often the most environmentally sensitive parts of the landscape, may be a way of reaping an economic return from this land without contributing to further environmental damage. Sites that should be avoided include land that is close to woodlands, which provide habitat for marauding squirrels, and land with exceedingly compacted soils, though this can to some extent be alleviated by subsoiling before planting.

Layout

The ideal layout of a planting depends on objectives, time and money. Mature bushes may be 10 to 12 feet tall and 6 to 8 feet wide, but it takes up to eight years to attain these sizes. To develop a closed hedgerow quickly, such as is desired for living snowfences, shelterbelts, and windbreaks within-row spacing may be as close as 4 ft. between plants. Although this increases costs for planting material, it may reduce weed control costs by allowing faster canopy closure. For production plantings, a wider spacing of 6 to 9 ft is desirable to ensure access for harvest, if harvest is to be by hand, but if a mechanical harvest is planned, such as with a blueberry picker, a closer spacing of 4 to 5 feet may be better.

Between-row spacing depends on what kind of equipment will be used to mow the vegetation between rows. The width of the equipment plus an additional two to four feet to allow for bush growth is recommended. Ten feet used to be recommended, though many growers now wish they had gone with wider rows. Some growers alternate 10 or 12 ft rows with 15 or 16 ft ones to ensure access. Annual crops, such as vegetables, may be grown between rows to maximize economic returns during establishment years.

Soil Preparation

Because you can expect your hazelnut planting to live and be productive for well over fifty years, the expense of good site preparation will pay off over the long run. Several months before planting, the soil should be tested for P, K and pH, because these are most effective if incorporated into the soil and amending these is easier before planting than after. Amend soil P and K levels according to recommendations for other fruit crops, such as grapes, given in the U of M Bulletin "Nutrient Management for Commercial Fruit and Vegetable Crops in Minnesota" (BU-05886). Although hazelnuts are tolerant of low pH, it is advisable to apply lime if pH is below 5.6, using rates recommended for your state. Use dolomitic lime to supply magnesium if soils test lower than 100 ppm magnesium.

It is essential that perennial weeds, such as other woody vegetation, brambles, and quackgrass, be eliminated before planting hazelnuts, ideally the year before. This can be done with a burn-down spray of glyphosate (Roundup™), followed by plowing a few weeks later, and an additional spray of glyphosate (Roundup™). For growers who wish not to use herbicides, repetitive plowing can do the same job: plow, and then plow again when regrowth is observed. The down-side to this is that it destroys soil organic matter, may cause soil erosion, and may stimulate germination of annual weeds.

If no perennial weeds exist, plowing may be unnecessary. It is possible to simply kill sod with glyphosate (Roundup™), and plant directly into that, especially if planting will be by hand. For machine planting, however, a well-worked planting bed is essential, especially if following sod, which can interfere with the cutting disks. If the subsoil is compacted, subsoiling is recommended. The anticipated longevity of the planting justifies the cost. Two passes are recommended, one in each direction down the planting row, followed by another operation to smooth the surface. In any case, it is never necessary to till the alleys between rows except in the case of potentially noxious perennial weeds. By leaving the alleys untilled, erosion is better controlled.

The hazel flower emerges to be pollinated; this will develop into a hazelnut cluster.
Photo courtesy of Roy Cerling

Planting Material

Currently, the only planting material available is from open pollinated seed, though research is underway to develop vegetative methods of propagation, which will mitigate the genetic variability inherent in seed stock. There are two types of seedlings currently available: "tubelings" which are 3 to 5 months old at time of transplant and which are actively growing, and "bare-root dormant", which are 10 to 14 months old when transplanted.

Tubelings can be transplanted whenever they are ready during the growing season, generally from May through early September, though planting in the searing heat of summer is not recommended. They come in sizes ranging from six to nine inches long. The larger sized seedlings generally have better developed root systems, which may confer better survival, but they may not be appropriate for machine planting.

Bare-root dormant seedlings, which are older and much more robust, must be transplanted during the early spring before they break dormancy. This leaves little time for soil preparation if it was not done the previous autumn.

Planting

Planting is best when the weather is cool and moist. If you must plant at a hot time of year, plant in the cool of the day and only if irrigation or another water source will be available immediately after planting.

Planting methods vary depending on the type of planting stock and the scale of the planting. Tubelings have very delicate root systems and should be planted with the care given to vegetable transplants: avoid breaking roots or compacting the soil too much around the newly planted seedling. Bare-root dormant seedlings are sturdier and do not need to be treated so carefully. If the seedling still has the nut attached, it is advisable to remove it before planting, because the nut is an attractant to rodents that may dig up the seedling in search of the nut.

Landscape fabric, drip tape, and mulch were used in this planting to suppress weeds and provide adequate moisture. A grass cover crop is maintained between rows.

Currently, most planting is done by hand. Simply dig a hole just a little wider than the root ball, gently pull the seedling out of the container and place it in the hole. Fill the soil back in around the roots, and water it into place. If the soil is light, or has already been worked, the only tool necessary may be a digging fork, bulb planter, or trowel. Some growers have even found that a dibble stick is adequate; for bare root dormant seedlings a "tree hoe" enables fast planting by hand. But if the soil is heavy a soil auger may be necessary for making the holes. With a dibble stick or auger, or in soils with a high clay content or which are very wet, it is important not to smear the sides of the hole, creating an impenetrable barrier for the young roots, or worse, creating a bowl in which the young seedling may drown in case of heavy rain. It is also important to plant the seedlings at the right depth. The soil-less potting mix in the containers tends to act like a wick, drawing moisture away from the young plant if it is exposed to the air, so the seedlings must be planted deep enough to cover it with about half an inch of field soil. However, if the holes are dug too deeply, the seedlings may sink down as the soil settles. Therefore, dig the hole just deep enough to accommodate the root ball plus half an inch, no deeper. The final step is watering to remove air pockets in the soil and to settle the soil around the roots.

For larger plantings, seedlings can be transplanted with standard vegetable transplanting machinery, such as is used for tomatoes or tobacco, but this requires a very well prepared and firm seedbed, as well as a team of workers. Bare root dormant seedlings may be planted with mechanical planters designed for other trees.

Maintenance

Weed Control

Research shows that young woody plants of all kinds do better with good within-row weed control. In small plantings this can be accomplished by hand, by pulling or careful hoeing of weeds. A sharp hoe that can cut through weeds at ground level is most effective and will not damage hazel roots. A weed-free area of about 1 to 1 ½ feet around each plant is desirable. Woodchip mulch and landscape fabric have been found to be beneficial by some growers, with the added benefit that they help conserve soil moisture. However, mulches can provide habitat for bark-eating mice. Landscape fabric should break down after four or five years to allow for new stems to grow through it. Black plastic mulch is not recommended. For very large plantings, mechanical weed control has been found to work, either with a regular row-crop cultivator or with specialized equipment for tree plantations, such as a Weed Badger ™. Herbicides can be used, but require extreme care to avoid getting it on the young hazelnuts.

Between rows it is desirable to either plant cover crops or allow native vegetation to grow for soil erosion control and other ecological benefits. Cool season grasses and low-growing legumes, such as clover, are best since they are less likely to compete for moisture with the hazelnuts. These can be maintained with mowing. Once the plants are well established, after about two or three years, they can compete well against weeds on their own and between-row mowing is all that should be needed.

Watering

Supplying adequate moisture to hazelnuts during the establishment year, and perhaps the year after that, is critical to their survival. Irrigation may enhance the productivity of mature bushes as well. Half an inch per week is best, if not supplied by rainfall; an inch may be needed in droughty soils. Drip hose is the most efficient way of applying water, but the most expensive. Less expensive drip tape has successfully been used by some growers. Woodchip mulch can reduce watering needs.

Fertilization

Assuming that P and K were applied before planting, the main nutrient to be concerned about is nitrogen (N), though the N requirements of young hazelnuts are so low that fertilization is not needed in the first two years except in low organic matter soils (less than 3%). After the second year, N requirements increase with increasing size of bush according to Table 1, unless soil organic matter exceeds 4.5%, in which case apply none.

Table 1. Recommended-N rates for hybrid hazelnuts in the Upper Midwest for the first three years after transplanting.

Year	N to Apply oz per cu yd of bush volume
1 (establishment year)	0
2	0 – 0.125
3	0 – 0.25

Calculate bush volume as (bush width/2)^2 x 3.14 x bush height. For large plantings measure several bushes and average their volumes; multiply the amount needed per bush by number of plants per acre to get N application rate per acre.

For mature bushes, N recommendations are based on leaf analysis in combination with observations of their vigor and yield. Low leaf N alone does not indicate N deficiency if bushes are growing and producing well. But if growth is sluggish and or leaves are pale, suspect a nitrogen deficiency and send leaf samples in to a lab for analysis. Collect 20 to 30 leaves from a bush in late July, taking the top-most fully expanded leaf from each of 20 to 30 stems, and apply N the following year based on Table 2:

Table 2. Recommended rate of N fertilizer to apply to established hybrid hazelnuts in the Upper Midwest based on leaf N concentration.

% leaf N		N to Apply oz per cu yd of bush volume
< 1.9 %	Severely deficient	0.5 – 0.75
1.9 – 2.1	Slightly deficient	0.25 – 0.5
2.1 – 2.5	Optimal	0 – 0.25
> 2.5	Excessive	0

Choose the lower end of the range if plants are vigorous, and the higher end of the range if they are not.

Nitrogen fertilizer is most efficiently taken up when conditions are good for growth, when the plant has most use for it. Thus it is best to apply N under conditions of good soil moisture any time from May through August. Later applications are not harmful to the plants, but are more likely to be leached out of the root zone and to become environmental pollutants. Slow release forms of N fertilizer, such as tree stakes, Osmocote, or organic manures, including leguminous cover crops, are likely to minimize environmental losses and increase N uptake efficiency though more research is needed on these.

Keep in mind that no amount of N will solve a problem caused by deficiency of other nutrients. Besides N, P, and K, other nutrients that may be deficient in hazelnuts include Boron and Zinc. Recommendations for these can be found in the Oregon nutrient management guide for hazelnuts available at http://extension.oregonstate.edu/catalog/pdf/em/em8786-e.pdf.

Insects and Diseases

Currently hybrid hazelnuts have no insect or disease problems of sufficient concern to merit control. They have been selected at Badgersett Research Corporation to be resistant or tolerant to Eastern Filbert Blight (EFB), the most serious disease of the European hazelnuts grown commercially in the Pacific Northwest. This disease is native to the wild hazelnut populations in this region, and thus the wild hazelnuts are naturally tolerant to it and have conferred this trait to these hybrids. They may get the disease, which appears as black cankers on older woody stems, and although it may kill an individual branch, it rarely kills the whole plant because these multi-stemmed bushes just grow replacement stems. The same is true for stem mortality caused by bronze birch borer. Big bud mite is another significant pest. This microscopic mite colonizes leaf buds, causing them to enlarge but preventing the emergence of their leaves. Genetic resistance to big bud mite is being selected for.

Other Pests

The biggest pests of hazelnuts are mammals and birds. Rabbits, deer, mice, pocket gophers, and others have all been known to nibble on hazelnut leaves, stems and roots, if only out of curiosity. Although the seedlings can tolerate a little grazing, too much can decimate a new planting. The type of protection that is best depends on what kind of animal is likely in your environment, and your own preferences. Deer fences, mesh cages, spiral tree wraps, and repellants, including a home-made egg spray, have all been found to be useful depending on the circumstances. (Details on the egg spray can be found on the Badgersett website.) Although grazing control is generally needed only through the first season or two, pocket gophers can kill plants up to five years of age and should be controlled with trapping or poison in their burrows.

At harvest time, squirrels, mice and birds, such as crows and blue jays, can be significant problems. Hawk roosts and various systems for scaring them away are necessary because they can run away with your harvest just as soon as it ripens. Timely harvest is also important, as most animals will not harvest the nuts before they are ready. Squirrels are an exception and may warrant extra control measures.

Harvest

Hazelnut bushes will usually produce their first nuts in their fourth year, though they will not come into full nut production until year nine or later. Hazelnuts start to mature in late July in parts of Iowa; in Minnesota harvest is typically from mid-August through mid-September. Nuts should be harvested just as soon as they become loose in their husks to avoid losses to predation. In some plants this may occur when the husks are still green and moist, whereas in others it may not be until they are brown and dry. In general, if the clusters can be pulled from the bushes easily they are ready to harvest.

This hazelnut bush, surrounded by a clover cover crop, has some unique and beautiful purple leaves.

Currently all hazelnuts in the Midwest are harvested by hand. However, it has been found that a mechanical blueberry harvester works well on hybrid hazelnuts with no modification. This machine straddles the rows and pulls the mature nut clusters from the bushes, leaving immature ones for later harvests. As enough plantings in the region reach maturity it may be possible for growers to purchase one of these harvesters cooperatively.

Post-Harvest

If husks were still green and moist at harvest time, to avoid predation by squirrels, they need to post-ripen for a week or two in conditions of high humidity but with adequate light and air circulation. Under a sprinkler in a greenhouse or other protected location is one possibility. If the husks were starting to turn brown at harvest time they should be allowed to dry completely by spreading them out in a well-ventilated (but mouse-proof) location, hanging them in mesh onion bags, or placing them in a crop dryer at a low temperature until completely dry.

The next steps are to husk and shell the nuts. Small quantities can be husked by hand; larger quantities can be husked with a variety of home-made implements that involve beating the clusters to break the husks followed by cleaning them with an old fashioned seed cleaner. Prototypes of commercial huskers have been developed and await commercialization. The industry is waiting for a sufficient volume of production to make production

of these machines worthwhile for the manufacturers. Likewise with shelling equipment, though a variety of home-scale shellers are already available.

Other Considerations

After about twelve years, hazelnut bushes will often become overly large for easy harvest, with declining yields. They can be rejuvenated by coppicing them to the ground during the winter when they are dormant. They will re-grow vigorously, and be back to full production within two or three years. Coppicing can be accomplished with a sickle-bar mower or with equipment for harvest of other woody biomass crops, such as hybrid poplar or willows. The coppiced material can be used for biomass energy. Coppicing does not have to be done on a planting all at once, but can be rotated through a planting over several years to spread out labor requirements and to ensure some harvest every year.

There are three methods of removing a hazelnut planting. Coppicing alone will not kill them, but coppicing followed by immediate application of a systemic herbicide to the stumps will kill them. A slower method is to coppice them repeatedly until they deplete their stored root reserved. Or they can be yanked out of the ground with a tractor and chain. (We hope you never really want to do this!)

References:

Olsen, J., 2001. Hazelnut Nutrient Management Guide. Oregon State University. http://extension.oregonstate.edu/catalog/pdf/em/em8786-e.pdf

Rutter, P.A. 2005. Hybrid Hazelnut Handbook. www.badgersett.com/HazHandbook1.html

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For additional information on hazelnuts and 3rd crops in general, please contact **Rural Advantage**:

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Hybrid Hazelnut Production Timeline

	Year	Activity	When	Inputs Required
Site Preparation (Year before planting or early in planting year)	**0**	Eliminate existing vegetation	When convenient	Roundup and sprayer, or tillage equipment
		Soil test. Apply P, K and lime as needed.	When convenient	Soil test, P, K, lime and application equipment.
Establishment	**1**	Pre-plant tillage or sod burn-down	May - June or late Aug - early Sept	Roundup and sprayer, or tillage equipment
		Lay landscape fabric if planned.		Landscape fabric and landscape fabric laying machine if a large planting.
		Planting		Hand-tools (shovel, bulb planter) or mechanical transplanter.
		Watering (1/2 - 1 inch/week)	Immediately after planting into early fall.	Water wagon, drip hose, or sprinkler system.
		Within-Row Weed Control	As needed through growing season (usually 3-4 times)	Hoe, or mulch, or landscape fabric, or row-crop cultivator, or herbicides applied with a wick system or sprayer with a shield.
		Between-Row Weed Control	As needed through growing season	Mower
		Herbivore control	Immediately after planting through winter, especially in winter.	Fences or cages, repellents, bait, traps, etc.
Growing Years	**2 - 4**	Continue watering, within-row weed control, between row mowing, and herbivore control, though with diminishing intensity as plants grow and can better fend for themselves.		
	2	Leaf Sampling	Late July	Send to a lab.
	3 - 5	Fertilize	May - Aug	Fertilizer and application equipment.
Maturation	**5 – 11**	Continue mowing and fertilization as above.		
		Nut predator control	Summer	Erect hawk roosts etc.
		Harvest.	Mid-Aug.- mid-Sept	Buckets, bags, and lots of labor, or mechanical picking device.
		Dry, husk, shell and sell nuts!	When convenient (Winter)	Lots of labor or mechanical huskers, cleaners and shellers.
Coppicing	**12**	Cut bushes down.	Dormant season (Nov-March)	Sickle-bar mower, brush cutter, etc.
Regrowth	**13**	Relax! (and mow)		
	14–23 26-35 etc	Continue watering, weed control, mowing, leaf sampling, fertilizing, and harvesting as above.		