

NUT GROWING ONTARIO STYLE

**BOOK
YEAR
2011**

Author - John Gordon

Nut Growing Ontario Style



**PUBLISHED IN COOPERATION WITH
SOCIETY OF ONTARIO NUT GROWERS &
NEW YORK NUT GROWERS ASSOCIATION**

CORNFIELD PECAN



GI-183

DIKEN PECAN



GI-199



SNAPS

PC-101



EMMA K BLACK WALNUT



THORP SINGLE LOBE

SAUBER

HAMBLETON

ELMER MYERS



GIBSON PECAN

PK COLBY PC-123



DEJAY



DEERSTAND PECAN PC-125



RIDGE HYBRIDS



DOUGLASS HYBRIDS



SIMPSON



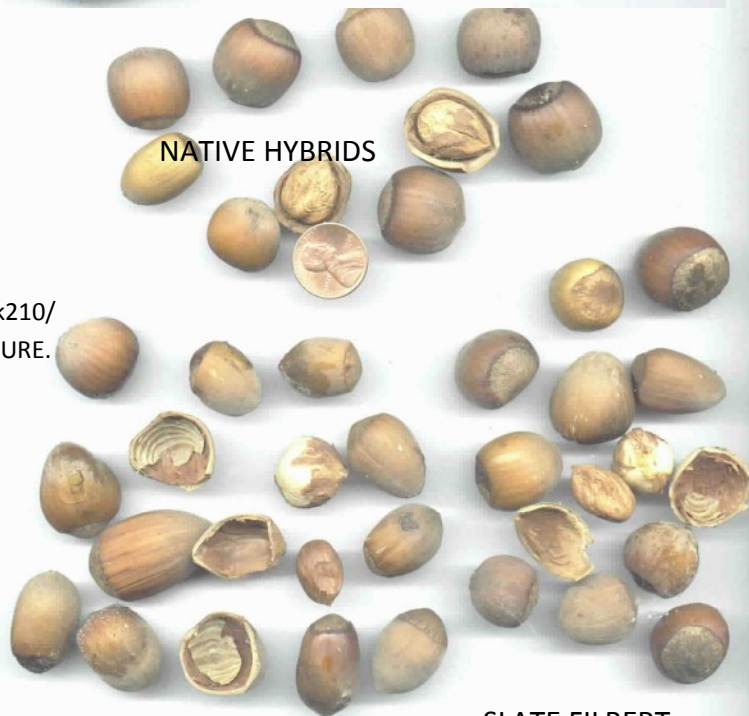
HYBRIDS



LAYEROKA



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NATIVE HYBRIDS

TREE FILBERT HYBRIDS

SLATE FILBERT

FRONT COVER, BACK

NUT GROWING ONTARIO STYLE

ISBN 0-9696374-0-3 - Second Edition - First Printing 2011

Library Cataloging

Gordon, J. 1938-

Nut Growing Ontario Style

172 p. (pbk.)

1. Nut- and minor fruit types.
2. Nut-propagation.
3. Nut-culture.
4. Nut-breeding.

Reference to Prior Publication ISBN 0-9696374-0-3 - First Edition - Second Printing 1993

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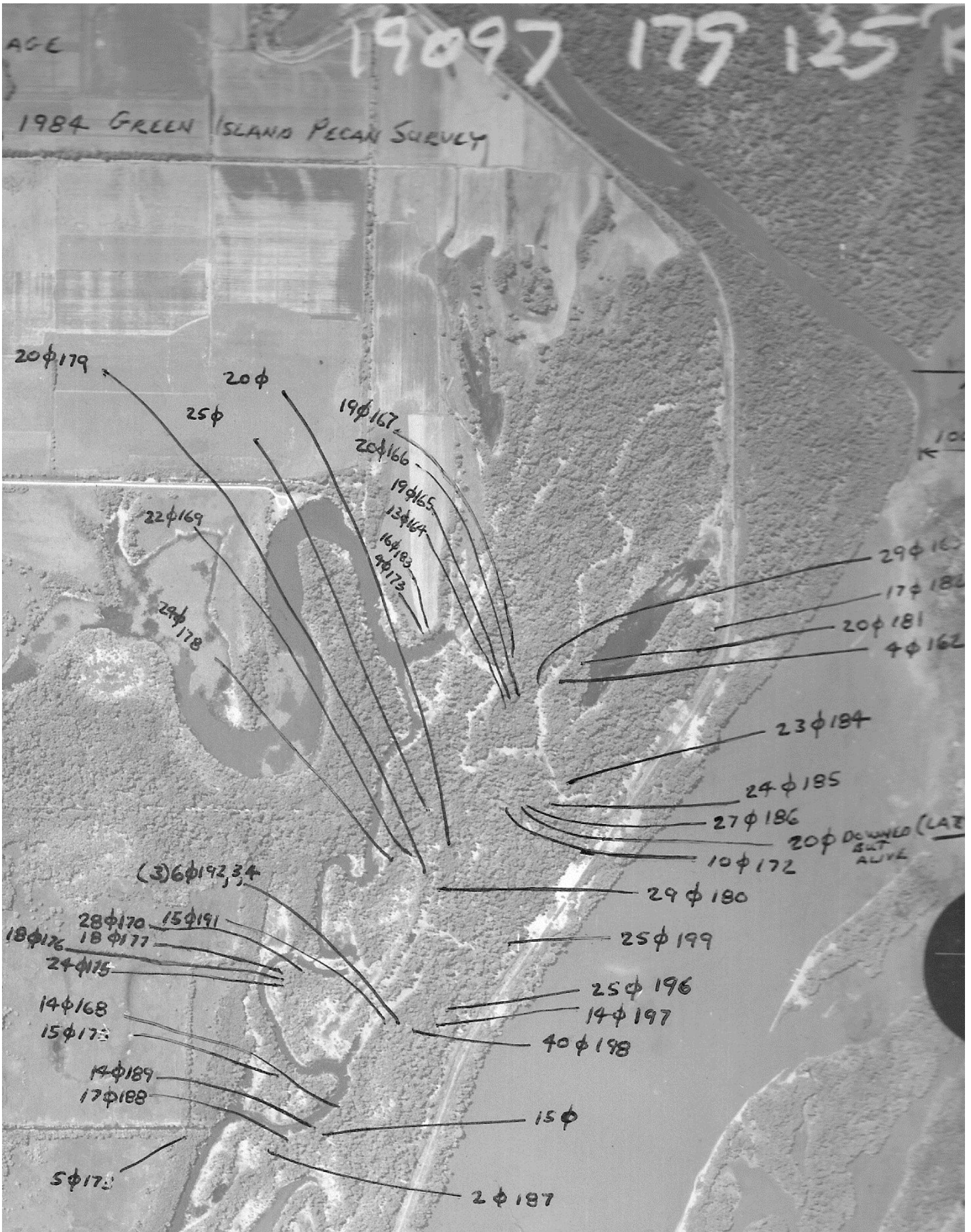
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3. Nut-culture.
4. Nut-breeding.

COVER

Sweet hybrid chestnut (top), hybrid tree hazel (bottom), and a map of the northern nuts region are features of the cover. Sweet chestnut and tree filbert (hybrid tree hazel) are particularly adapted to Ontario/NY. The map indicates the land area we have crisscrossed while gathering nut selections which are now bearing in Ontario/NY.

PROLOGUE

I have never seen an Angel, ET or her UFO, Ghost, Orb, Monster, Apparition, Big Foot, Crop Circle, Past Life, or Out-of-Body Experience. Why? After listening to “Coast to Coast AM” for years, I have the impression that I am the re-incarnation of a tree. Plus, My Guardian Angel must also be the re-incarnation of a tree for he is never seen, or heard, but must think far into the future to keep me out of trouble. My neighbor threatens to come over, and throw a shovel of dirt on my foot to see if I root. J G

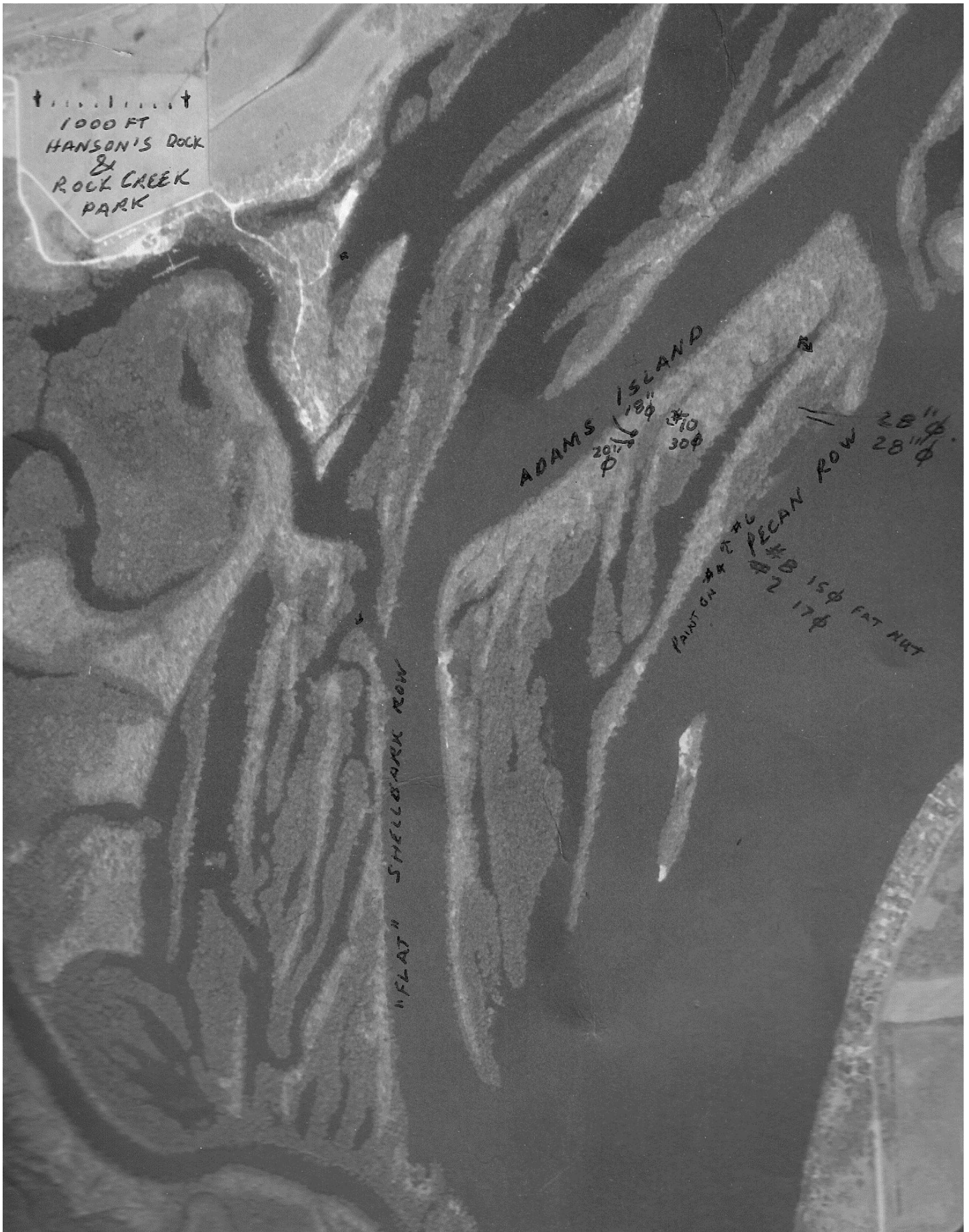


1984 MAQUOKETA DELTA SOUTH AT THE MISSISSIPPI

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COVER ii, BACK

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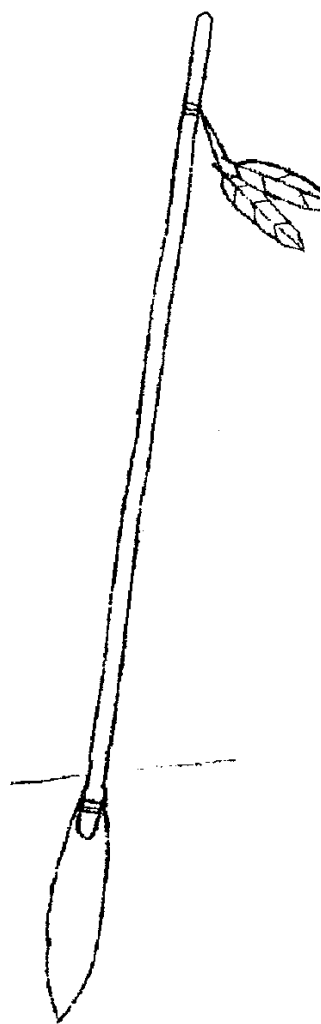
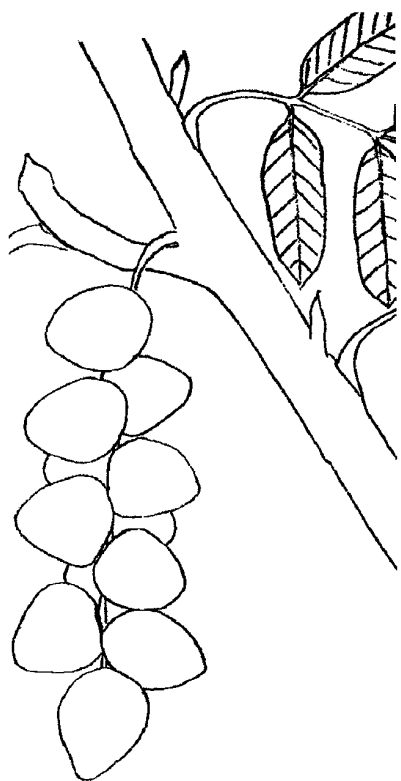
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OVERVIEW NUT TREES AND THEIR GROWING



I. The Society of Ontario Nut Growers (SONG) published the first editions of this book as a guide to people interested in establishing nut tree plantings in fluctuating temperate climates. Recently Ernest Grimo wrote a book, "Nut Tree Ontario" to update this book, and I produced this 2011 update to spread growing to NY, and the New York Nut Growers Association, NYNGA, pronounced ninja. People believe that the Great Lakes Region is at the fringe of nut tree profitability, if not survival. However, since the formation of SONG on October 14, 1972, NYNGA in 2002, productive nut trees (North American natives as well as European and Asian introductions) have been reported growing from Edmonton through Montreal. Hardiness is led by hazels, then on to butternuts, black walnuts, heartnut hybrids, heartnuts, chestnut hybrids, Chinese chestnuts, and Persian walnuts (hardy English), their selections which have been proven. Some far north pecans are dropping fully ripe in Ontario and NY. Establishment of the imports follow many failures. Thereafter, hybrids occurred naturally. Many hybrids have gained the hardiness of native nuts, and the kernel quality of imports.

II. To grow northern nut trees successfully, the rules about **nature** and **nurture** have to be followed. The nature rule says that hardy, productive and satisfying trees (and nuts) are genetic inventions. Besides having production and quality in their genes, they have the ability to overcome climate, soil, weed, insect, disease, and predator competition. The main difference between natives and imports is that the natives are not easily pushed into growth, or quickly recover, from cold-snap injury by our weather. The nurture rule says that it is culture, starting with choice of site, which allows the full potential of nut trees to express. **Don't** pay attention to these rules, and you are playing a high risk lottery. Which rule is more important? The one you forget. Without best-practice culturing the finest tree will not meet its potential.

A. Many people plant a tree as though it were a spear. Stick the right end in the ground and, like magic, it grows. Not so. We must visualize the conditions which permit a tree to grow. Temperature rise forces carbon dioxide from sap, pressurizing the sap. The sap can be expelled through wounds, or drive the rapid flush of new growth. At night the sap cools, carbon dioxide goes back into solution, and the vacuum created draws more sap from the roots. Trees which are only stuck in the ground, whose roots function poorly, risk a net water loss and drying. It may be that only pine trees are made for spring transplanting. Their leaves sense moisture, and closing pores to save water. With a start from sap, leaves (needles) arouse to make food with air, and minerals from solution, which energize trees to grow. Roots are spread, and easily heal in the sun warmed upper soil, and gather soluble minerals to feed leaves. Pines transplant easily due to many surface roots. Spring transplanted nut tree roots can match surface pine roots if their roots are also spread in the sun warmed upper soil. These begin recovery in spring, though full recovery takes a year, or two. Many nut trees have extensive, and deep roots. Because their deep roots are in deep soil they recover in late summer unless potted above ground. In-ground recovery usually takes until late fall, and three years until hickory and pecan make full recovery.

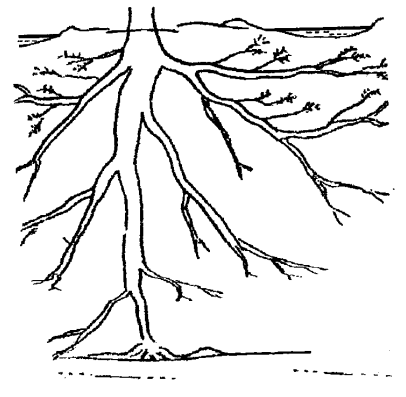
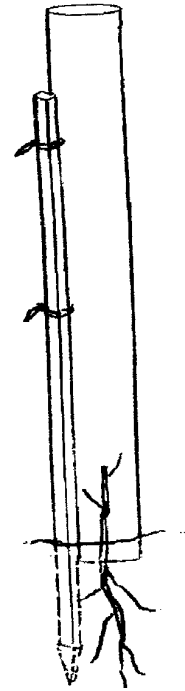
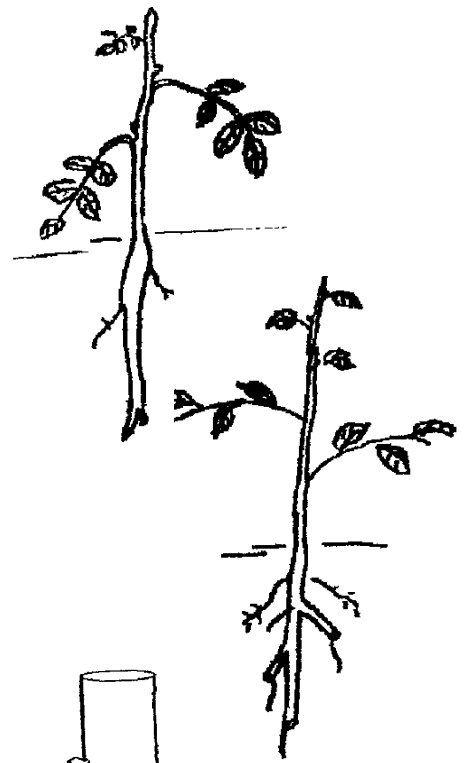
B. Granular fertilizer is the best growth producer. Buy in bags or bulk from farm supply what is available and economic...12-12-12, 14-14-14, or 15-15-15. It can burn plants if used incorrectly. These salts burn any live plant tissue it contacts. 14-14-14 Osmocote OVERVIEW 1

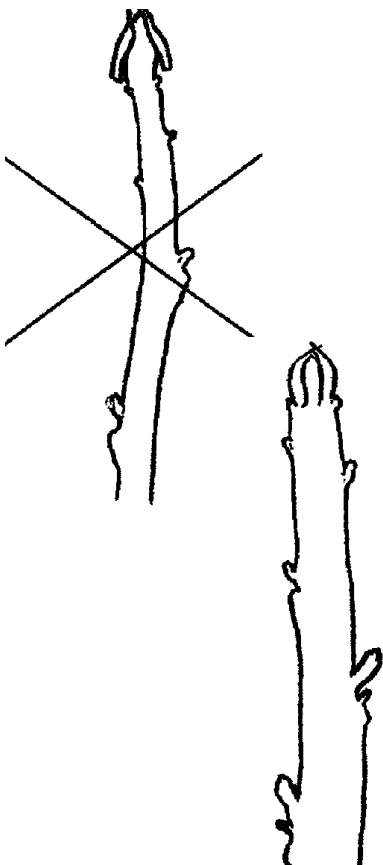
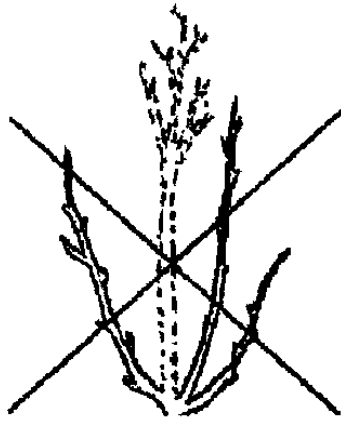
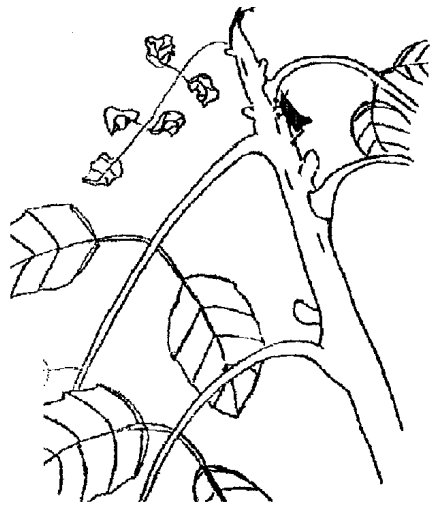
fertilizer is coated with sulfur so can slow release at tree roots and bark without injury. Even so, the tree roots should grow to it, not mix with it. This requires large planting holes, and sticking "sticks" of fertilizer deep into the sides of the holes. Only a cup of bone meal should be mixed with the re-plant soil to force the root system to reach out of the planting hole. Doug Campbell recommends going heavy on the cheap, but high power granular by mixing it outward with the surface mulch/soil and renewing it every few growing season months, even risking injury. Keep spreading outward through the tree's life. Slow growth is the injury suffered from too little fertilizer. Persimmon is stressed by too much nitrogen. The injury shows up in winter, so eliminate the last spreading, and cut back more if winter injury is noticed.

B. Deep rooted trees gain root recovery most quickly, if transplanted holding some leaves in early fall. (I hate to write this because my soil is a brick yard in the fall, impossible to dig most trees in fall.) The transplants need to be easy to dig in fall, have warm soil for callusing and root growth, moist soil so some root functioning feeds leaves, and some leaf functioning to feed roots and stimulate their growth.) Root growth parallels leaf functioning. (A difficulty arises with white oak. Any leafy tree which hangs onto leaves until spring will require more water from its roots than they can supply in their reduced condition. So nip off leaves at the end of the growing season.) Deep roots grow during summer and fall. That is why spring transplanting relies on uninjured root systems with some surface-feeding roots.

D. Persimmon is a test tree for the expert at transplanting. Planted as a spear, persimmon drops its leaves upon being water stressed. No leaves, no root recovery. Leaves push out again, but the above ground portion of the tree is too weak to survive the next winter. The several ways around these difficulties are: water persimmon transplants with warm water acidified with azalea Rapid Grow whenever the soil dries, fall transplant with trees at peak health. Place the root system to let it re-grow from sun warmed roots which are planted horizontal. (If the tree is a sprout from root cuttings, it could be cut low to come up again much as a seed. This third case is not for grafted persimmons.) Transplant into a greenhouse/tree shelter. Temporary planting in a pot until late June often helps hickory and pecan.

E. Tree roots need oxygenated water. Oxygenated water is usually on the move from where it fell as rain, to streams, and on to the sea. Tree roots intercept it and use it to move minerals and food stuffs. Tree roots will not grow in stagnant, oxygen deprived water because oxygen is as essential to their cell functioning, though they need less oxygen until soil warms. Chestnut trees drive roots to flowing ground water. Large surviving American chestnuts are usually above permanent springs. Pecan trees along the great rivers pump water made oxygen rich by water swirling through sloughs and the banks of granular soil between them. How do we get oxygen to tree roots? By making sure rain water flows through the soil. Dish the soil surface so that moderate rains do not run on the ground surface into streams. Use organic mulch to open a tight soil by attracting worms, and their burrowing. Install drain tile to lower the water table and increase the downward flow of heavy rains. Each time a saturating rain draws down through the soil it pulls in air, oxygenating the soil. Hickory trees often grow in tight soil where the spring water table is high. Speculation is that hickory, with its rapid flush of growth in spring, pumps out a bowl of aerated soil. Carbon dioxide pressure causes the quick flush of foliage, which then takes over to draw water.





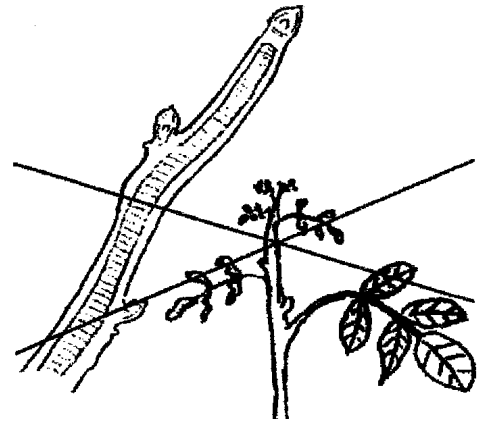
1. Saturation of the soil surface is a concern where crown rot fungus swims from host to host. Apple trees are the main victims though chestnut and tree hazel fall victim. Species first, then varieties will have to be matched to site. Some are suitable/resistant, some susceptible.

2. Small chestnuts and Persian walnuts have new growth snarled by heavy attacks of leaf hoppers (Not their large trees which harden leaves early.) These tiny greenish insects are usually hiding in foliage and tall grass from late June through August. Disturb them and they fly like tiny grasshoppers. They slit succulent growth and suck fluids. Injury looks like drought curl and shrinkage. Organic gardeners easily grow in town where mown ground, large solid objects like sheds, and street lighting keep leaf hoppers away. Small orchard trees have to be sprayed. A bare earth mulch is helpful. Hickory escapes by early flushing/hardening of leaves, but if they go to second growth it is usually ravaged. Attacked trees grow too late into fall, and lose terminals even if the winter is mild, and the next spring is gradual.

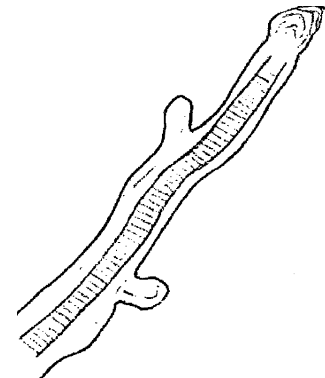
III. The true nature of a nut tree shows through, if it is given adequate culture. Differences in the genetic code express wide differences in growth. We see wide variation in a row of Persian walnut seedlings. Many runts remove themselves. Given a good seed source, only a minority look thrifty and in step with our climate through varying seasons. Most Persians jump into rapid growth in a warm early spring, remaining succulent, and growing too late, lack hardiness. Those which move buds early (often leaf early) often loose buds which have hardly swollen, freeze crack, frost leaves, then are infested by walnut bacterial blight. Once the hardy individuals are found out, up-land planting, and the removal of grass shows that we can grow Persians. Pecan is similar once it is determined which pecans match black walnut in the greening of their leaves early.

A. Hardiness is being concentrated in Persian walnut seedlings by growing out successive generations. During the 1930's Rev. Paul C. Crath introduced many Carpathian strain Persian walnuts which he collected during his mission work in Poland. Our widely fluctuating climate produces much spring injury in Carpathians although the extreme cold of the Carpathian Mountains is seldom reached. These seedlings continue to grow, but become shrub-like. Freezing back causes too much shrubbiness in Carpathians due to a mistaken rush into spring and frost. Unless you are within a mile of one of the Great Lakes, avoid Carpathians. A bit more hardiness and we have a class of Persian which makes a tree, but regular tip injury prevents cropping. This class has a crown which is too dense and bushy. Dead twigs and walnut blight abound. A few of the original Carpathians grew to look like nut trees, but later failed when their care givers retired, and no longer cultivated to remove grass from under their trees. Large surviving Carpathians are tall which gets through frost to have crops of fine nuts. This is the type most of us have in mind when we set out to grow Hardy English walnuts. We have great hopes of grafting high on black walnut, or moving high onto to a better site. Yet, it is wise to get quality Persian graft wood from an expert with Persians from the very few mid-continent sources with blight resistance. "Mid-continent hardiness" and "blight resistance" hardly ever occur together in the same Persian. NYNGA is establishing breeding orchards with nuts from select strains.

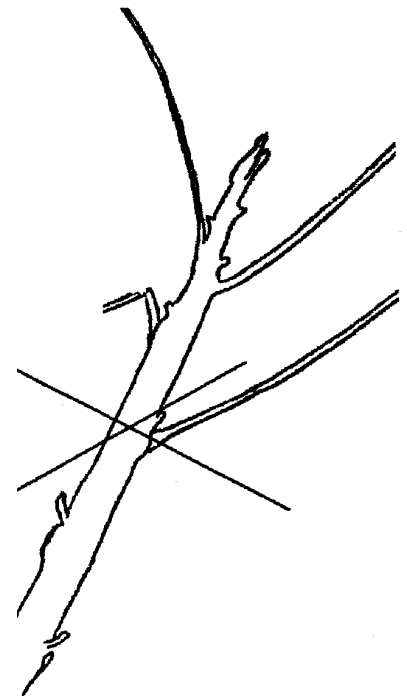
B. What if Persian walnut seedlings are to move to harsher locations than where they were raised? Large seedling Persians near the shore of the Lakes have seldom been checked for hardiness though this is easily done by growing some of their seed/seedlings. Experience has shown that Persians from Toronto do far better in Niagara than Persians from Pennsylvania. The same is true for Chinese chestnut, although heartnut and filbert easily make the move from anywhere to Niagara. Because Persians and oriental chestnuts are likely to be tender we have to demand that they look hardy with the terminal bud a king bud with scales well formed over plump leaf material. After harsh winters the seedlings must grow out from tip buds. The tip bud should be as completely formed as lower buds. Persian terminals should be crowned with long, thick bracts which uncouple at the bud tip, unfolding into growth in spring. The diameter of the current year's growth (bud wood) should hardly taper or be ridged in its upper growth. The bark of the bud wood should be brown or dark grey throughout its length. Green bark is associated with growth late in the season, not a hardy tree. Persians, which grow moderately, and maintain stout wood at their terminals, are in tune with our season. Stout growth is not the growth pattern of typical Carpathians, which are more willowy in our climate.

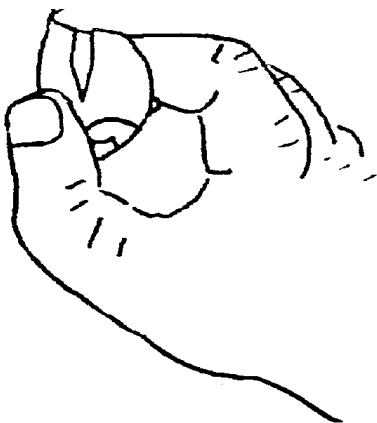
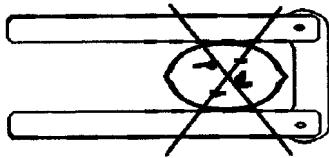
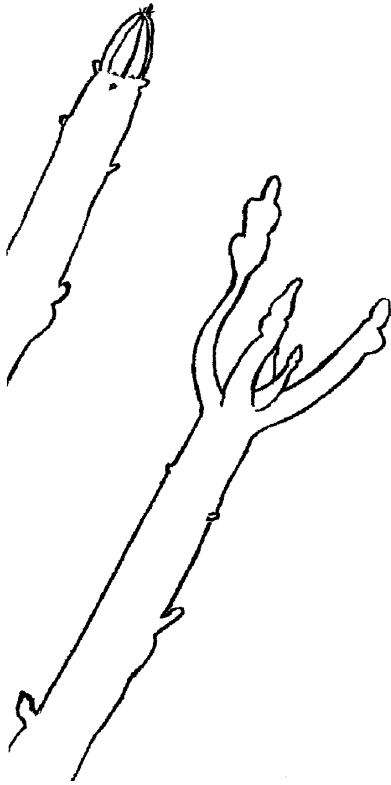


C. Tip die-back is observed in typical Persians walnuts, Japanese chestnuts, Chinese chestnuts, paw paws, mulberries, and pecans. It is flagged by leaf petioles which stick on at tip buds through winter, or burst free at killing fall frost with noticeable injury and bleeding at leaf scars. Often, when these trees grow large, they are thick with dead twigs. Few bear except from side buds.



D. Until nut cropping on seedlings is demonstrated, final selection is not possible. In Persians the gamble is reduced because so many have fine nuts. Check bearing at six years old (3 in./8 cm. diameter trunk). Female flowers should be observed in late May through early June. Young walnuts do not have pollen the first years of female bloom, so pollen must be brought in, or on a neighboring older tree. Nut clusters of two and three should be common, and hang on until mature. In late summer the nut quality is inspected. Nuts should be self hulling weeks ahead of typical hard freeze. Way before harvest the terminal buds should be sealed with grey bracts to endure frost. Only dormant terminals survive, and they contain next season's female flowers. Any bud on a projection of extended wood is a terminal bud, even if it is on the side of a terminal shoot. Leaves remain functioning past nut hull splitting, and drop in mid-October, even when the growing season extends to Halloween. Leaves turn yellow when the abscission layer forms at the leaf scars. As long as leaves function they replenish sugar and wick moisture from the soil, but they cannot drop with frost the next day, except on some hardy pecans, which need the crop shook down, and stored before frost. Leaves may color yellow, starches changing to sugars, but dropping early in a normal season indicates that the tree is for a shorter, more northern growing season.





E. Persian walnuts are examined here because their hardness is visible and varies widely. All species contain individuals for moving north, or south. Nature provides many seedlings, and the grower must intelligently move the seedling around, nourished into production, and into variety status.

F. Northern pecan has indicators that help us select its best sorts. The trait of making dark green leaves at the same timing as black walnut is the best indicator of Ontario/NY adaptation. Hull splitting before Persian walnut is needed because, if pecan has a wet kernel and freezes, the kernel discolors with spoilage, while neighboring walnuts are not injured. Later ripening pecans will have to be shaken down and taken to curing, hulling, drying, and storage before hard frost.

G. Although fully ripe, many nut species hold onto their crops until released by light frost, heavy dew, or rain. One must be observant to get these nuts before squirrels, or crows do. The wind often needs to assist in shaking nuts down. Then there are the persimmons and pawpaws that size, and start to color then freeze, and continue to ripen in Indian Summer.

H. Bud tips are sheathed in small leaves resembling bracts in walnuts, hickories and pecans. Hickories, chestnuts and hazels/filberts sheath all their buds in scales, including their tip bud. Pecan is unusual because it forms a sock over all buds. Several of the earliest northern pecans pop off the tips of these socks before winter begins. Individuals in most species partially open buds before winter, reason unknown/impetuosity. Butternuts and heartnuts break bud early, growing the bracts on their tip buds into leaves (this is a vast difference from Persian which only has to swell bud to be frost tender.) The first green bracts seldom survive the last spring frost without injury, but if they do it will be a great growing season. The flowers at the center of these buds are seldom injured. The trade off is that early growth is sacrificed for latent heat which helps protect the flower that is only partially exposed. We wish Persians had this characteristic.

IV. Black walnut is our reliable producer of large kernels and valuable logs. Hammond's Products in Missouri favors round black walnuts because they crack best run through progressively narrowly gaped roller crushers. Ernie Grimo in Niagara favors round walnuts and roller crushers. Otherwise, four large lobes surrounded by a very hard shell are not quickly, and easily cracked. If a black walnut is end cracked like a pecan it needs to be a long nut with thin shell, and divided by four long slits through which the lobes connect to the embryo. These nuts exist, but are in the minority which is a problem when trying to change the current industry. Most of the current nuts are round, not thin shelled, and their lobes connect to the embryo through small, round, shoelace holes. I favor a long nut like Emma K, which has long slits connecting lobes to embryo so the shell is set up for end cracking.

V. Heartnut has the best shell structure for easy/clean cracking. Putting pressure on the sides of a good valentine heartnut with vice grip pliers will release the shell into two halves. The kernel will dump free. Persians and filberts are also good nuts for cracking indoors. Pecans are also, if the percussive rubber-band type, end cracker with plastic canopy is used. They have thin shells. The northern pecans which we have ripened are often too small to crack in the typical mixed-nut (lobster claw) crackers which often crush kernels. All pecans call for percussive end nut crackers.

VI. Dry, cool storage is needed to hold quality in oil rich nuts. Oil nuts contain antioxidants throughout their shells to prevent their oils from oxidizing while they are drying and curing. Chestnuts are often very good eaten fresh and raw. They can be taken into a semi-heated room a few days before eating to lose moisture until the hull dimples, and the kernel becomes spongy and sweet. Then finger pressure will pop off the hull and pellicle. Nut stone pines, black walnut, and butternut are not easy to hull, crack and extract. Emma K black walnut, and several butternut X heartnut hybrids are well worth the effort. Tree hazels stick in their husks, sticking them out of our reach, but still available to animals. Yet, the unbeatable quality of tree hazel hybrid kernels encourages us to harvest them and improve their self-hulling.

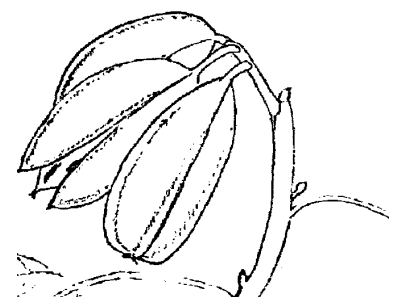
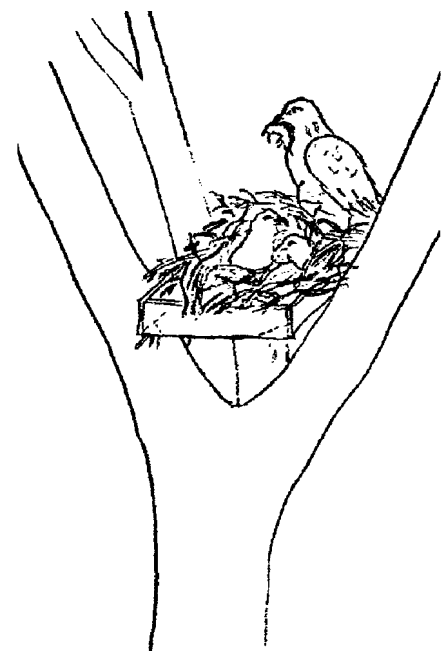
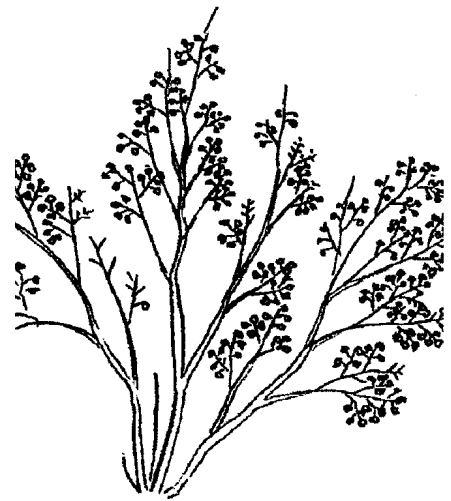
VII. "What nut varieties do you recommend for our region?" This question is often asked by nut enthusiasts from remote regions. Soil, pH, minimum temperature, warmth of the growing season, and length of the growing season point toward the proper species and variety. Sometimes we know of a their local grower to be contacted. What works for him is the first to try. After local sources are exhausted we need hints about local cropping. If the only local fruit is Saskatoon serviceberry, the likely nut is Gellatly's Peace River hazel hybrids, or Eastern Filbert Blight resistant hybrids from Phil Rutter. Korean or Siberian stone pines might be substituted where low bush blueberries are the only local fruit. Dropping down to apple and pear regions, the hybrids of filbert, heartnut and chestnut should be the first to try. Depending on their success, hickory, and black walnut varieties are next to try. Finally, try Persian and pecan. Tender fruit (peach) growing areas can grow great selections of most species, including some almond. Almond is seldom recommended because it has the same diseases as plum.

VIII. Introducing new crops takes effort. SONG has gained some public funding to establish trials. Chestnut, heartnut and filbert testing at the Simco Horticultural Experimental Station, Ont. comes to mind. A few northern nut growers are making money. A major issue is: Can nut growers make a living only growing nuts? If none can, what is our message? The message is speak of nut growing as realistically as we can. Some statements from nut growing regions to our south come to mind: It takes 100 acres of pecans to afford the drainage/irrigation, sprayer, branch rake, mower, tree shaker, and pick-up/processing equipment. This is an up-hill battle which means a lot of cooperation between growers, and the call for better selections.

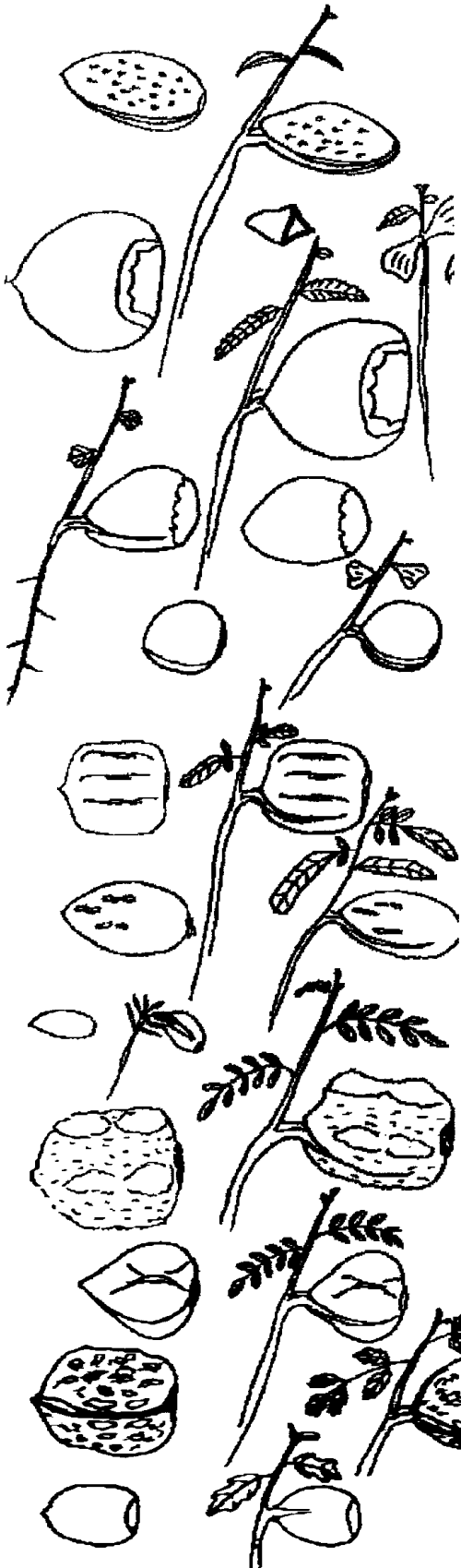
A. The demand for good nut material is constantly increasing, buoyed by each successful crop. Although nurseries have to satisfy the demand for nut material, SONG's role is to transmit information on all aspects of nut growing: culture, selections, source, range, research, use, demonstration, etc. If toward the greater good of nut growing, SONG feels the involvement.

B. SONG has a web site, www.songonline.com which gives information on meetings, etc. The technical meeting is in February, usually at Simco, Ont. The spring auction meeting is late April/early May in Toronto. There is a summer meeting (conducts society business, visits plantings and processes), and a fall meeting to visit plantings and see harvests.

C. NYNGA has the same goal and a web site, www.nynga.org which gives information on three meetings (spring, summer and fall), etc.



BASICS OF NUT GROWING



Almond (*Prunus amygdalus*)

Beech (*Fagus grandifolia*)

Chestnut (*Castanea sp.*)

Chinese (*C. mollissima*)

European (*C. sativa*)

Japanese (*C. crenata*)

American (*C. dentata*)

Filbert (*Corylus sp.*)

European (*C. avallana*)

Native Hazel (*C. Americana*)

Turkish Tree Hazel (*C. colurna*)

Nut Pine (*Pinus sp.*)

Korean (*P. koraiensis*)

Colorado Pinion (*P. edulis*)

Single Leaf Pinyon (*P. monophylla*)

Hickory (*Carya sp.*)

Shagbark (*C. ovata*)

Shellbark (*C. laciniosa*)

Pecan (*C. illinoensis*)

Walnut (*Juglans sp.*)

Black (*J. nigra*)

Butternut (*J. cinerea*)

Japanese Heartnut

(*J. ailantifolia* var. *cordiformis*)

Persian (*J. regia*)

Manchurian (*J. mandshurica*)

Ginkgo (*Ginkgo biloba*)

White Oak (*Quercus alba*)

Red Oak (*Quercus rubra*)

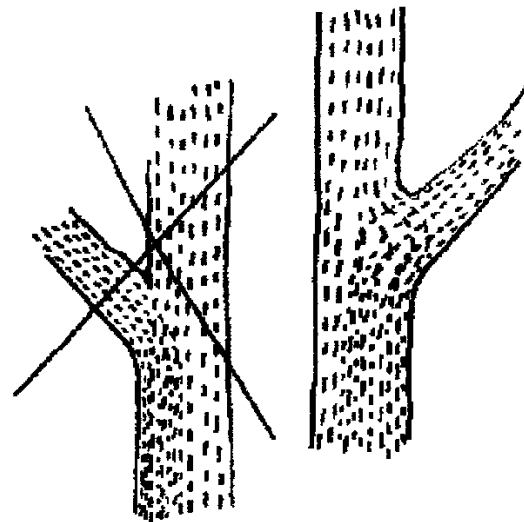
I. The Society of Ontario Nut Growers (SONG) first published this book as a guide for growers interested in planting and harvesting nuts in our unpredictable climate, though we call it temperate.

A. Allergies from Nuts: US Food and Drug Administration warns about allergens in all tree nuts. These cause anaphylactic shock in some humans. It is interesting that Shea nuts and its butter receive this warning, but is put in many creams/baby products/European chocolates. Studies show human immunoglobulin E barely binds to the remaining Shea protein, causing no reaction.

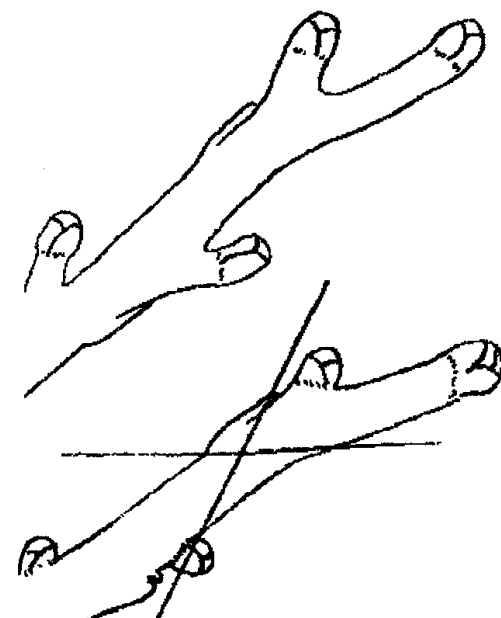
II. Two principles govern growing: What is grown./How it is grown. Our nut trees must be genetically programmed to bear despite fluctuating weather and marginal sites. Secondly, we must maximize conditions which ripen nuts early, and ready the tree for the next crop. We continue to find productive and disease resistant trees which have crackable, tasty nuts. The nitty-gritty of nut growing is testing new selections, and discarding varieties whose faults we no longer need to suffer.

A. Our climate is quirky. Few imports from Eurasia endure uninjured our rapid weather changes (Take the Alberta Express, please.) The hardiest come from harsh latitudes, and flat elevations at mid continent. Imports, known to withstand deep cold, fail here due to our January and February thaws. They break dormancy, and easily flush growth. Indoor fall grafting of Persians is discouraged because buds easily break, and they have to be taken to cold storage through winter. A far north pecan will break bud any time in spring, but it takes moisture and 75°F /24°C for 3 -4 days. Hybrids hold promise when combining old continent size/cracking with native sweetness and hardiness. We must thank plant explorers like Crath and Shreve, and persistent breeders like Corsan, Gellatly, Slate, and Weschcke for distributing better-adapted nuts. Many hybrids, Persian walnuts, and Chinese chestnuts are moving genetically toward commercial status, but all have hidden problems for removal. Song has several conservation plantings. NYNGA has set out a plantings of blight and frost resistant Persians. We change trees, not mountains. BASICS 7

B. What do we grow? Hardy, productive trees with quality nuts. Buds are completely formed and sealed by September. Stems are thick with wood, relatively little pith. Trunks take sunny, snow intensified, March days and arctic nights without cracking. The sheath of wood which forms under the cambium fully wraps trunk wood into limb wood. Winter sun, then freezing, does not wound bark low on the trunk, or in crotches of large limbs. The bark is thick and checkers with cork soon after its first season. Insects and disease pests seldom slow growth. Buds do not move in March/early in April. When buds do move after false springs, they form large undistorted leaves. Side buds are large, usually on a projected stalk, which can carry flowers if first buds are injured. Leaves are large, dark green, thick and glossy. Pollen forms each year, but most sexual energy goes into nutlets. Nutlets form throughout the tree with a cluster of sunlit leaves nearby for their feeding. Kernels form just early enough to mature. Nuts ripen, cure, flavor, and come down near mid-September to Sept. 30. The tree recovers for next year's crop from mid-September to mid-October. In September new bark growth is light brown and dormant. If second growth is caught by freezing in September, injury is held to the succulent tip wood. The central leader flows to the top of the tree without competitors (exceptions are the fan stemmed filbert, more so many hybrids that need correction.) Side branches should not become vertical, but tend outward with strength at the crotch, and bend outward horizontal for light gathering and food storage. Roots should not sucker, wander on the ground, or go far from the tree. Side roots must hold quantities of mycorrhizal fungi (which display like needles on fir trees). These mycorrhizal hyphae vastly extend the roots, break down soil, extract minerals, and enter them into the roots.

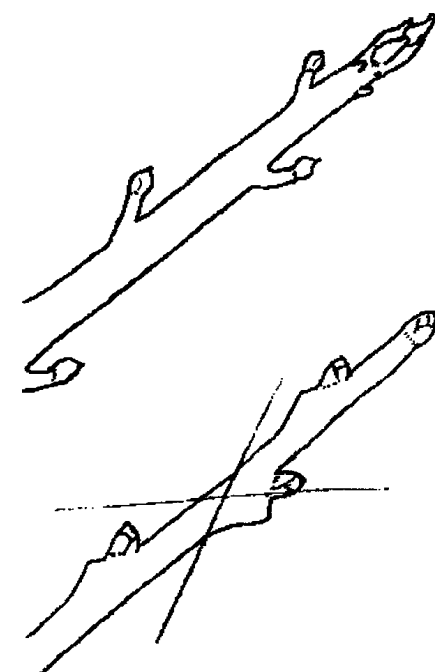


C. Whatever a tree needs, it must be furnished, or the tree must quickly grow to it. Sunlight, warmth, aerated water, fertile soil, calcium in the subsoil, and especially the growth hardening mineral potassium must be sufficient.

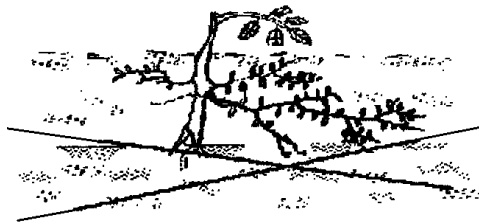


III. Nuts are large edible tree seeds: a reservoir of energy, food goodie.

A. Nuts gather enough food to propagate trees in a forest. They start life as an enlarged tip-of-stem leaf set. After easy pollination their flowers do not completely abort. Many embryos set in each nut, but quickly only one embryo survives, we hope. The leaves near the cluster of nuts delivers food to them, and into tree.



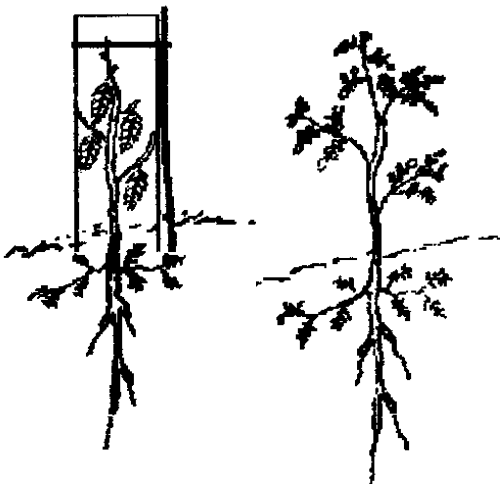
B. Planted nuts break down oils to acid to start root growth out flower end/embryo of the nut. Beechnuts, white oak acorns, pinion pine, chinquapin, and many southern nuts must start growth in the fall. With warm moist conditions a root (radical) emerges and turns down into the soil. Stem growth waits for spring. Most northern nuts cure in fall, freeze during winter, and germinate under warm moist conditions in spring. Moist, cool curing, then drying, builds the most nut flavor. Moist curing with good aeration, stratifies a nut as when a squirrel noses a nut just barely into the ground. This is sufficient for cold storage and spring germination. Nuts, which are about to germinate, are bitter. Acids are bitter for growing as IBA/ indolebutyric acid, the rooting hormone, is bitter, as is the same break-down process in butter, where butyric acid is oil turning rancid. Pawpaws send root at 67-80°F/20-25°C, and come up in August as a little plant completely free of the seed, or "chill out" until next spring.



C. After the root radical descends about 6 inches/15 centimeters a shoot arises where the nut attaches, and ascends. Mycorrhiza grow on the nutshell, and inoculate the radical as it emerges. Other mycorrhiza grow into the root from the soil as the root extends. Healthy seedlings will have a heavy display of fungi by the end of summer.



D. That first fall the best seedlings cannot be chosen because buds set later than in future years. Nor can characteristics of this individual be identified because most growth was produced by the food sack, not new roots and leaves. The best hardiness check waits for the third, and start of the fourth growing season when die back can be seen on second and third year growth. Selections can be made in the third growing season on the basis of second year die back, leaf size and gloss, growth rate, and bud set on third year growth. At the beginning of the fourth season selections should be about 1 foot/.3 meters part with a few runts between. The struggle-to-dominate suppresses the flowering in otherwise fruitful trees.



1. Spacing at a length equal to how-tall-the-tree-is brings the trees into full sun. Full sun increases bearing quickly, and fully, but not as quickly as taking graft wood, and top working a large tree in full sun. Removing the tree top can open a lot of the tree to full sun as well as slow the rush sky-ward. This pruning broadens trees to increase production, but requires continued light gathering, and light penetration pruning.

2. Spacing by .0689% butt area for bearing= 30 SQ FT per Ac.=1/1500. This ratio for best bearing is a "best fruit ratio" as used by fruit growers.

a. Maximizing nut production will necessitate pruning of injured or deficient nut producers to allow light to the best trees, probably envisioning height equals spacing cutting/pruning. In that way existing spacing can be extended in time until the fiber stress ratio (twice the best fruit ratio) cannot be ignored, which is how the tracks on the thinning chart are drawn.

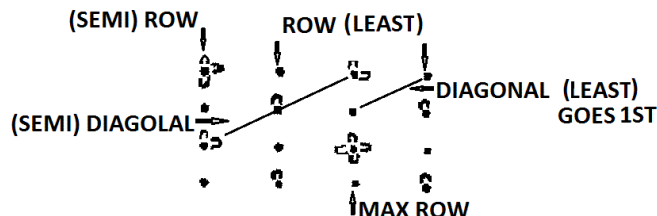
b. You have a choice whether to cut, or move good young trees growing near each other. Once they get big your only choice is when to cut.

3. Spacing by .1377% butt area optimum fiber= 60 SQ FT/Ac. fruit has declined and fiber (log) production rate is max.

a. If the value of logs is great, it is likely cutting logs will be marked, or delayed by your forester.



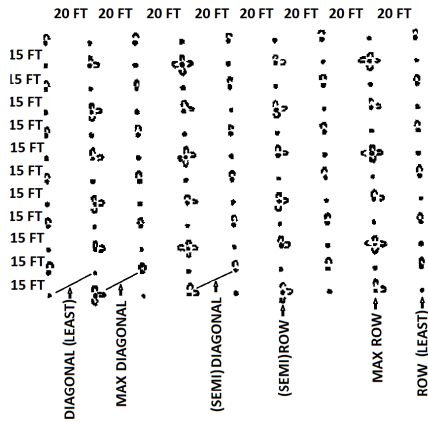
16 BLACK WALNUT TREES ARE THINNED TO ONE TREE,
1 TREE ON 4800 SQ FT/ 80 FT BY 60 FT.



1ST THIN REMOVES DIAGONAL (LEAST) 8 TREES GO
 2ND THIN REMOVES ROW (LEAST) 4 TREES GO
 3RD THIN REMOVES (SEMI) DIAGONAL 2 TREES GO
 4TH THIN REMOVES (SEMI) ROW 1 TREE GOES
 MAX ROW BECAME PERMANENT 1 TREE STAYS

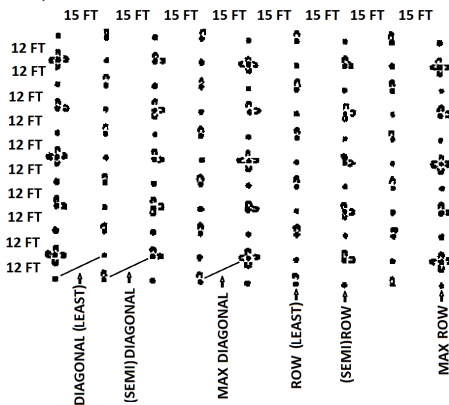


BLACK WALNUT ORCHARD - SPACING FOR THINNING TO 80 BY 60 / PERSIAN WALNUT / PECAN ORCHARD

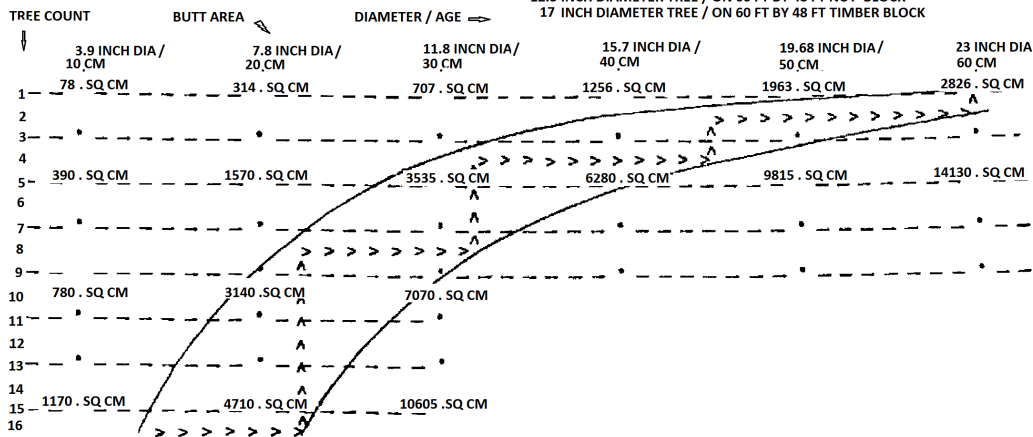


WHEN YOU NOTICE THE FOUR LEAF TREES ARE MAX, YOU SHOULD KNOW WHERE THE PERMANENT TREES ARE.

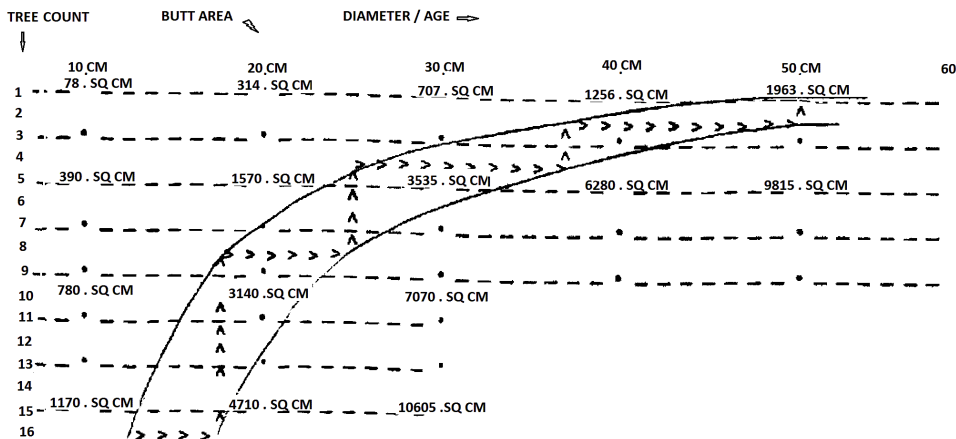
CHESTNUT ORCHARD - SPACING FOR THINNING TO 60 BY 48 / HEARTNUT ORCHARD / HICKORY ORCHARD



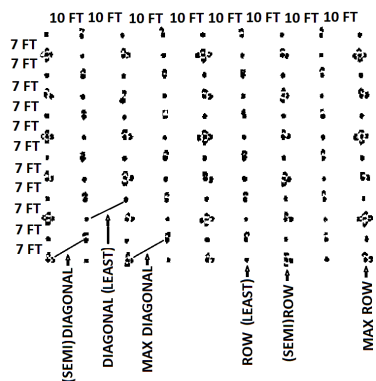
16 TREE BLACK WALNUT SPACE THINNED TO 1 (SPACE 80 FT BY 60 FT/TIME 10 YR TO 60 YR) IF GROWTH RATE IS 1 CM PER YEAR, 12.5 INCH DIAMETER TREE / ON 60 FT BY 48 FT NUT BLOCK 17 INCH DIAMETER TREE / ON 60 FT BY 48 FT TIMBER BLOCK



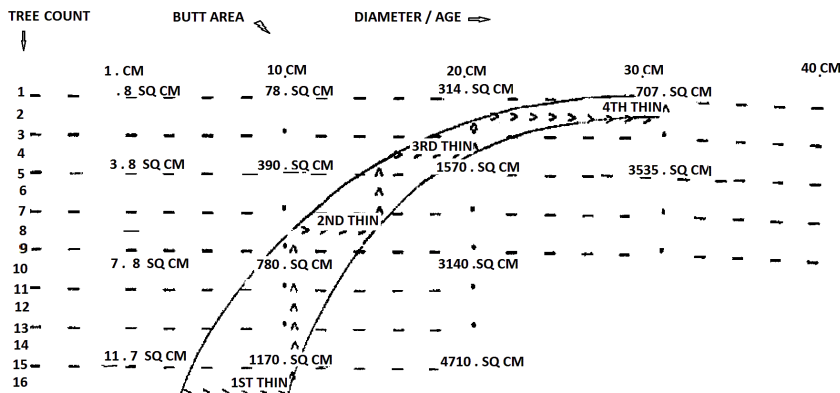
16 TREE CHESTNUT SPACE THINNED TO 1 (SPACE 60 FT BY 48 FT/TIME 10 YR TO 50 YR) IF GROWTH RATE IS 1 CM PER YEAR



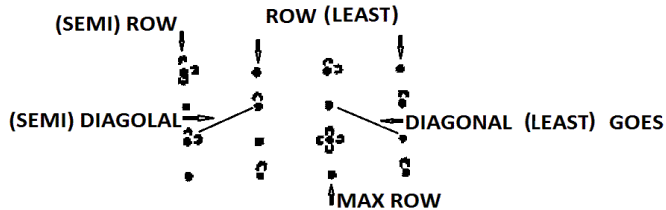
FILBERT ORCHARD - SPACING FOR THINNING TO 40 BY 28 / PAWPAW ORCHARD / PERSIMMON ORCHARD



16 BUSH FILBERT SPACE THINNED TO 1 (SPACE 40 FT BY 28 FT/TIME 10 YR TO 40 YR) IF GROWTH RATE IS 1 CM PER YEAR



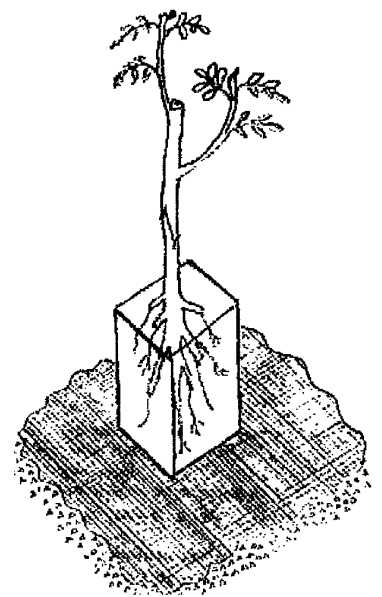
16 CHESTNUT TREES ARE THINNED TO ONE TREE, 1 TREE ON 2880 SQ FT / 60 FT BY 48 FT.



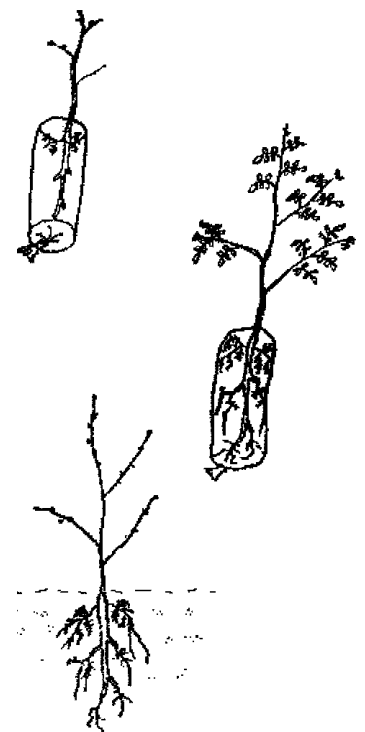
30 SQ FT BUTT AREA / ACRE
FOR
DIAMETER
60 SQ FT BUTT AREA / ACRE
NUTS / TIMBER

1ST THIN REMOVES DIAGONAL (LEAST)	•	8 TREES GO	
2ND THIN REMOVES ROW (LEAST)	•••	4 TREES GO	15 CM 23 CM
3RD THIN REMOVES (SEMI) DIAGONAL	•••••	2 TREES GO	20 CM 30 CM
4TH THIN REMOVES (SEMI) ROW	•••••••	1 TREE GOES	25 CM 35 CM
MAX ROW BECAME PERMANENT	•••••••••	1 TREE STAYS	40 CM 60 CM
		16	

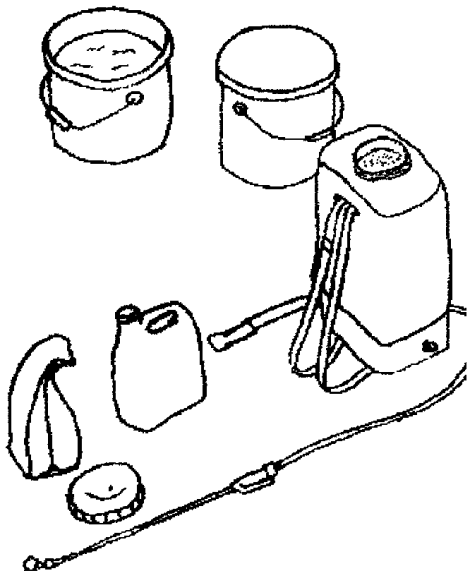
equipment rich, and fall is moist. Digging and planting is like in spring when 20 three foot seedlings can be dug one day, and planted the next. Where roots are single spikes, four feet long it takes three full seasons to recover, and renew their growth rate of three feet per year unless held one summer in a pot/greenhouse. Dig the planting hole larger than necessary. Drive a spike point to take some root. Discard weed roots and grass clumps. Break up the soil so it will filter around the tree root. Plant the tree with its crown 2 in./5 cm. above the original ground surface, and mound with 6 in./15 cm. of brought in dirt. Water the tree as it is planted to soften and help compact the soil. As the hole is topped up, water to wash soil completely around the roots (acidified water at pawpaw, persimmon, filbert, chestnut). The critical item in fall transplanting (less important than preventing leaves from greatly transpiring (prune most leaves), more important than soaking the root system) is to hill soil 6 in./15 cm. (more is better and will remove itself) above the root crown. Settlement of soil must not expose the root crown, or the **root crown will transpire** (vent) moisture, and kill the higher-up portion of the tree. With settlement a pocket often forms under the snow where mice nest, feasting on "nutty" tree roots. However, a grower who has begun a planting at orchard spacing can hire a tree spade to move trees in leaf with little injury to roots, and get full recovery in a year. Plant by early October because relatively warm soil, above 50° F/10°C, should regrow root tips by spring. Planting a tree in the fall joins the rhythm of nature, rather than disrupting it.



H. Spring is the time for most transplanting because nature provides cold storage while trees are dug, shipped, stored, replanted and re-sprouted. Due to cold spring soil some leaves must grow out before roots grow, and re-establish. Actually, roots in the sun warmed upper soil become functional while the leaves grow slowly. Small trees with many side roots do well when spring transplanted. Pines, filbert, heartnut and chestnut transplant easily in spring. Hickory, pecan and many walnuts will transplant in spring, and suffer. You can read it in their roots. Horizontal root systems spring transplant while vertical root systems fall transplant. To ease recovery, dig and plant uninjured root systems. Roots within 2 in./5 cm. of the ground surface (as do any roots in an above ground pot) recover quickly, and carry the tree through into summer. Any root exposed at the root crown increases desiccation often killing the top. Because root crown and roots should be in the sun warmed (but moist) region of the soil, a ground covering film is best employed to heat the soil and conserve moisture. Clear plastic (with weed killer like simazine) works better than dark firm because soil heats directly, and more deeply. Hoe (usually with a Roundup + simazine mix) the patch of ground 3 ft./1 m. around the transplant to keep grass, weeds, and their travelling roots away from the transplant. Grass roots interfere with tree roots by releasing carbon dioxide and other anti-tree chemistry. Tree roots need oxygen. Use Roundup + simazine in summer and simazine + Solicam in fall. Cold weather Solicam is uneconomic in spring as soil becomes too warm for any effect of Solicam.



I. Container growing nut trees is beneficial because trees retain functioning roots. RootMaker, Spencer-Lemaire in Edmonton, ALB, Stuewe & Sons make deep starting pots, about 4 inches square by 14 inches deep. Special precaution must be taken against roots coiling. Paint inside the pot with copper carbonate as latex painted inside walls (1 lb. per gal./100 gm. per liter), use open bottom pots (soil/above screen/above air), or bag in 6 in./15 cm., 6 mil plastic film duct, half inch/1 cm holes punched. Sausage-tie the bottom to trap roots in the folds. The containered trees should be held/kept watered in a lath house for the summer months, and planted out in early fall (perhaps the next spring). The air break between ground and pot which is so beneficial during summer must not exist during winter, or the pot will freeze, killing roots/trees.



1. Establishing trees in containers is elegant horticulture. The spring dug trees are set in deep pots with potting soil and moved into a lath house. Lath houses and newly potted trees warm and heal above ground in spring, and summer air. The tree roots are raised off the ground where they are warmed by the sun in semi still air. Watering is provided daily, if necessary, but usually less regularly due to moderated light, wind, and humidity. Small trees, which stall growth if spring planted in the field, usually double their size, if held in pots in a lath house over summer. See page HICKORY 84.

2. Root systems should always be pushed out the bottoms of containers, not pulled out by the stem. This is to keep the soil compressed against the roots. Whether pots are stacked milk cartons, coffee cans (plastic lid "bottoms" are hole punched), roll roofing, plastic film duct, or plastic pipe, the root ball is pushed through the bottom. The 6 in duct sleeve is pulled up the cylinder while backfilled during replanting.

J. Herbicides are very important to the tree grower. Herbicides reduce weed competition with a minimum of hand labor. A positive feature of nuts is that they may be grown without chemicals. However, a combination hand weeding and herbicides establishes the trees most easily. Apply chemicals according to directions on the label.

K. Given warm wet weather during the growing season, a nut grower with seed beds or small seedlings can spend much time weeding. If chemicals can be afforded, and equal those listed, weeding will be much more effective. Over-the-top herbicides are applied on weeds and trees without harming the trees. Simazine is often sprayed over the top. Solicam works like simazine, but faster and only in the cold months which makes them a good team in the fall at time of killing frost. Roundup has to be applied only on green weeds, usually rapidly growing, only in a low acid solution, and not when heavy rain is coming in the next hour before absorption by drying.

L. A valuable investment for a nut grower with about ten acres of small trees is a backpack sprayer. 5 gal./20 liters of spray can be put out each day in an hour from April through November. Spraying herbicide can start the season, or be a final job in fall. Spraying diluted latex paint can end the season in spraying the southwest sides, mainly, of transplants or grafts, protecting against winter sun/freeze injury (also add bitter Thiram fungicide to repel mice and rabbits). A reasonable budget is \$5 per day (\$400 per season without labor) to release 10 acres.

M. Tree shelters, plastic tree growth tubes, are designed to put a small greenhouse around a knee high tree. These translucent plastic tubes help block wind, moisture loss, and animal molestation. They are perfect for filberts and native chestnut, but other species suffer their heat (especially pawpaw), and need ventilation holes, 8 about, about 1 in./25 mm. diameter Swiss cheese pattern. Better than holes, fit shelters to 4in./10 cm. above transplants so leaves are sticking out in weeks, then remove. They can be permanent on filberts to prevent suckering by laying some lose leaf litter shade, and obstruction in the tube.

N. Shoots grow rapidly in shelters, but the roots and trunk often do not keep pace. Thus, the tube has remained too long, and now has to remain longer in a tree guard position to hold the spindly tree upright. Give tree shelters credit for greatly increasing tree survival, but have to be sized and monitored.

1. Wasps can build nests in tree shelters, and sting foliage to keep it wounded, and allow sun into their dwellings. Some citron lamp oil dribbled down the tube's insides, and on any nests solves the wasp problem. The mouse problem is solved by mouse bait.

2. Small tree shelters are used to direct grafts erect.

3. Small tree shelters are used to greenhouse rooting filbert, rooting mulberry, persimmon root sprouts, and pawpaw root sprouts, and send them off erect.

IV. Insects find nut orchards: apple leaf hopper, chestnut weevil/gall wasp/leaf mites, pecan weevil/case bearer/aphids, butternut curculio, codling moth, and walnut husk maggot come to mind. The internet and Google show much information on these out of the ag-schools/agroforestry organizations from Missouri to New Jersey.

V. Plant pathogenic bacteria and fungi: chestnut blight fungi, eastern filbert blight bacteria, Persian walnut blight bacteria, several butternut/heartnut bark and root diseases, almond viruses and fire blight bacteria are also researched on line/internet.

1. Integrated pest management relies on surveying pests and their predators: spiders, lace wings, lady bugs, certain wasps, and nematodes to target pests when they avoid/save predators to target the pests that could build to harmful populations. It works well when predators and their weed dwelling prey, and habitat, are maintained (includes letting strips of hay stand as pest fodder between orchard mowing) to keep predator population high. The bottom line is maintenance of tree health, and accepting a small proportion of damaged nuts, by growing pest resistant trees. Dud, diseased and weevil damaged nuts must be screened out. Good nuts endure the handling needed to remove trash. Check/google on Avaunt insecticide.

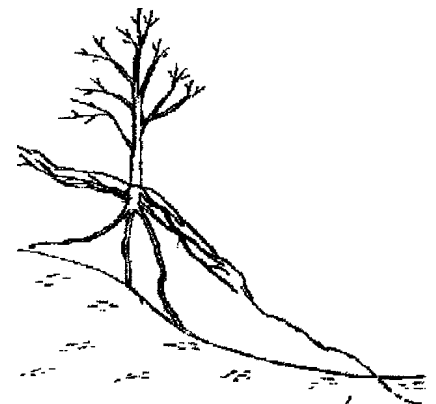
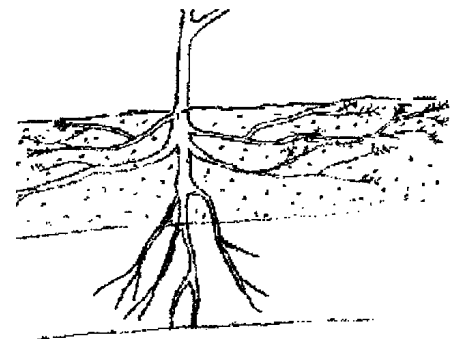
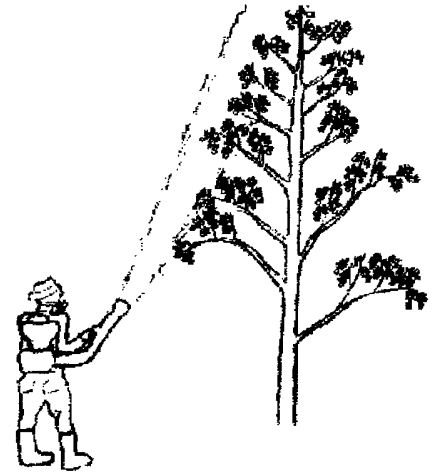
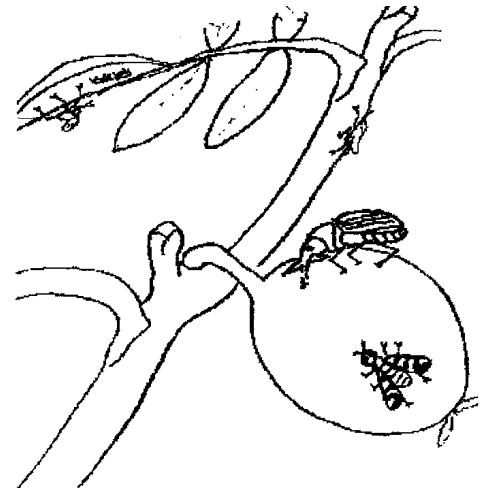
VI. Granular fertilizer is necessary. Without knowing soil and tissue analysis, one can only budget 500 kg. of 12-12-12 fertilizer, knowing we have to maintain a fast growing stand, and later, replace minerals taken off in crops. Granular fertilizer should extend out from the drip line of the tree to keep roots extending. It can be used as a chemical hoe on wet grass and weeds. Our glacial and lake deposit soils are usually deficient in nitrogen, phosphorus, potassium, sulfur, zinc, manganese, iron, boron, etc. Nitrogen usually produces the greatest return, and phosphorus is the most difficult to direct to tree roots where it is needed. Zinc and potassium are greening, and dormancy pills. Calcium is the regulator within the tree, directing the performance, and high concentration in nuts. Along with sufficient nitrogen, manganese, zinc and iron they produce healthy leaf color.

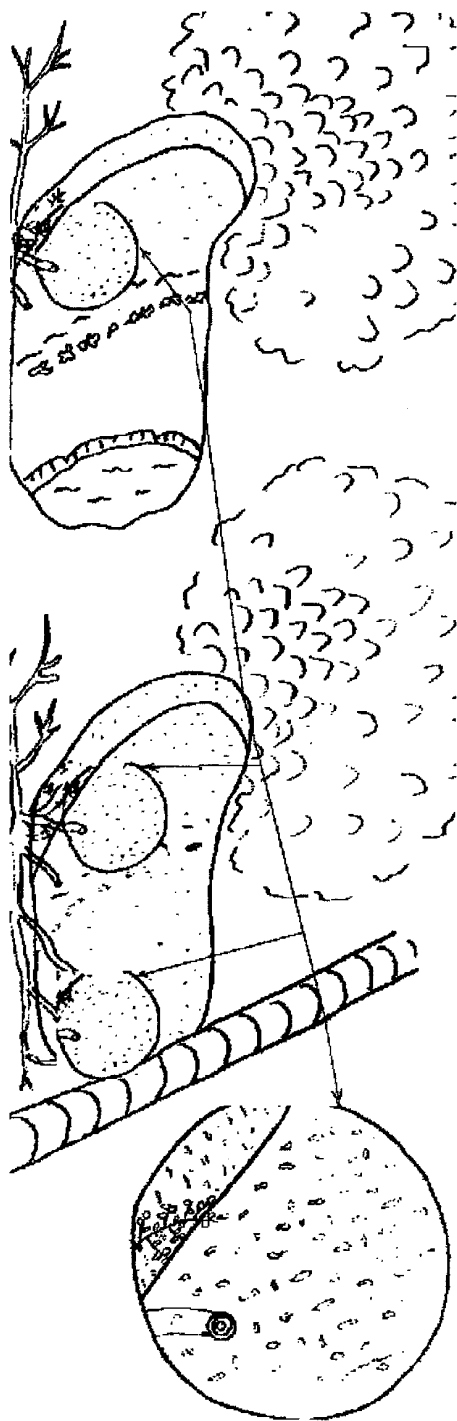
A. However, do not think that acidic chemical fertilizer will substitute for a deep, biologically active soil. Trees may suck up chemicals better than vegetables given enough time, but they don't feed directly, like vegetables. Their roots are condominiums of bacteria and fungi which convert the soil itself into soluble plant food and bring it into the roots. Destroy a biologically active soil and you destroy the way a tree grows, probably the tree. I have access to sintered sludge, and find it a great organic.

B. Another take on fertilizer is the instruction of nurseryman, Doug Campbell, who has started many nut trees. More injury is due to too little fertilizer than too much. Each time you notice slow growth and dark leaf color going pale, likely each two months into August, renew the granular. Use a balanced granular (15-15-15, or most economic), 2 lb./1 kg. per inch tree diameter, and scoop-sling it out from the tree to well beyond the drip line.

VII. Choosing the site for a nut grove is like choosing a site for fruit or other large productive trees. The soil must be rich and deep or the trees grow poorly, or size only while juvenile. Nuts want land which grows large trees.

A. Examine hill country fruit farms, usually irrigated. They are deep soils, sited above surrounding land. Higher sites drain cool air off at night which is replaced with lighter, warm air. Air drainage allows fewer frosts, faster nut filling, and quicker tree recovery for the next crop due to a warmer, longer season. The valleys, and clearings below, are frost pockets in which the relatively heavy cool air collects. In late summer when nuts are trying to fill, a valley tree can be two weeks behind a hill tree in ripening, and remain poorly filled. The narrower the valley, the higher the cool air puddles.





B. Soil drainage is very important. Trees roots need aeration (oxygen in soil). Water may saturate the soil during winter when the roots are inactive and the water retains dissolved oxygen, but as soil warms the oxygen delivery from standing water is too poor. Carbon dioxide, often delivered by grass roots and standing water, kills tree roots. Secondly, slow draining soils are cold and stall root growth early in the season. Thus, the need for 4ft./1.5 m. soil above water table. We try to find these soils by finding large hardwood trees that have healthy growth. After 2 in./5 cm. of flooding, the aerated water should reach 4 ft./1.5 m. below ground in 48 hours, and continue down. We get a picture of internal drainage by digging test holes at the orchard site. Digging 10 ft./3 m. holes indicates how roots will penetrate the soil. We watch for collected water, tree roots, calcium carbonate deposits, iron staining, hardpan or rock. A good soil exists if holes were comfortably dug by hand, and water, calcium carbonate and iron deposits were near the bottoms. Blue soil, indicating a lack of oxygen, should also be near the bottoms. Top soil should be 8 in./20 cm. or more thick, and dark with organic matter. Absent, or light colored topsoil may indicate that the soil is too rapid draining and the organic matter has burnt off. Such soil will need careful fertilizing, cover cropping and irrigating. Tree roots should penetrate toward the bottom of the test hole, through top, sub, and root end soil zones.

C. Percolation should balance between a droughty soil, where soil moisture drains too quickly, and wet soil which needs improved internal drainage. Droughty soils might be treated with lime, (and sulfur for chestnut), superphosphate, and green manure crops before planting. Candidate trees are chestnuts and hazels. Grow alfalfa hay in the row middles, after liming them. Organic mulch and hay from the row middles could be used around (not against) the trees to add organic matter to the soil. The soil grains need to be coated with clay or organic matter to hold water and minerals. Water goes down quickly, but horizontally slowly, except through a drain tile.

D. Drain tile is trenched into wet soil to drain the subsoil, and aerate the soil above. Drain tile is corrugated plastic pipe which is slit with holes to intercept water, and covered with a nylon sock to keep out flowing sand particles. Silty soils have **no sock**, or the fines pack against the sock and quickly ruin drainage. Drain tile increases the biologically active zone in the soil. Water percolates to warm the soil in spring, rather than standing/evaporating, which cools the soil. Improved drainage produces a much larger zone of soil/air/water mix, providing a reservoir of pore water, and minerals useful to tree roots.

E. Clay will hold much water, but without an active biology, it is difficult to get clay wet, or to release. The better orchard soils are granular with enough clay to coat grains, but not fill the voids. Water can percolate, but a large volume of air/water is held in the voids. A clay soil may be almost permanently damaged by compaction which closes voids, but is reestablished by using subsoil busting ploughs, deep rooted cover crops, and a healthy earthworm populations. However, you will too often have to traffic, and compact your wet orchard soil at emergencies, then wait for natural recovery.

F. Lake plain orchards are easier to establish than hill country orchards, but land is more expensive to buy. At less than a mile/1.5 km. from the Lake, the Lake stirs the air and produces warm nights in late summer and fall, like the high relief at orchards away from the Lake. The level fields allow rain to penetrate before running off. Drain tile produces the large air/water zone in the soil. Drain tile is most efficient where land stands 8 ft./2.5 m. above water in the municipal drains.

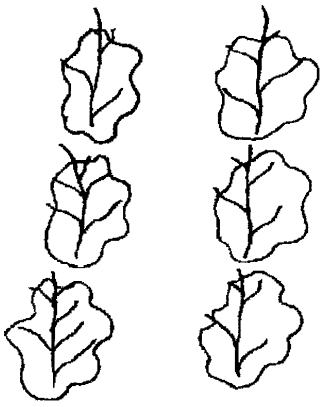
G. The chemistry and thickness of the soil is reflected in the species of native trees it supports. Deep granular semi acid soil supports white pine, red oak, native chestnut, aspen. Clayey acid shallow soil supports beech, pin oak, hawthorn. Clayey about neutral shallow soil supports maple, elm, ash, poplar. Deep neutral limestone soils support hickory, white oak, walnut, mulberry. Surface soil is usually acid due to organic matter breaking down, or leaching down its calcium carbonate. Subsoil is acid if broken down from granite or acid mudstone. Subsoil is basic if broken down from limestone, or basalt. Where nuts lodge, and grow, they grow roots to their favored soil, and try to convert other contacted soil to that pH. We are safest in growing nuts in topsoil that is slightly acid (pH 6.5) above subsoil that is basic (at pH 7.0). Nuts abort without calcium if it is not easily gotten from limestone subsoil. The internal breakdown of chestnuts is attributed to inadequate calcium because chestnuts transport it into large nuts poorly, except if it is supplied to nearby leaves, usually by calcium sprays.

VIII. Trees are water engines. They rev up in summer, transpiring more than 2 in./5 cm. of water per week. Where irrigation is installed, 2 in./5 cm. of water is budgeted. Rain and measuring water tension in the soil can reduce the irrigation. If trees are water stressed when nut shells are sizing, we have small nuts. Often these small nuts are so tightly filled that cracking damages the kernels. Chestnuts often split their hulls when rain returns. If water stress comes when kernels should be filling, the shell continues to thicken and delay the filling. If water stress comes just before ripening, the kernels are shriveled, and nuts refuse to drop. A tree which fails to replenish its water reserves before winter could succumb to desiccation during winter. Flower buds initiate (form) in the prior summer, if that was not a stress period.

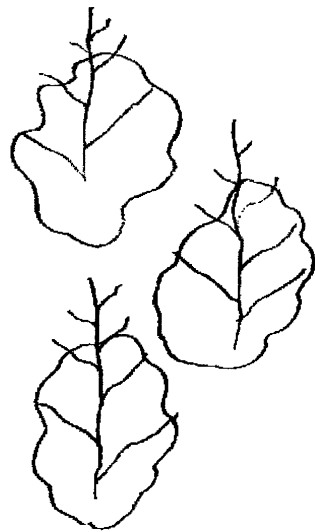
IX. Tree spacing is based on light interception. A fruitful tree must be in full sun through the mid portion of the day, 10 a.m. to 2 p.m. Go into a full production fruit orchard and check out a few rules. Tree canopies should shade 50% of the ground at noon. Trees should be as high as rows are apart. The tree butt area is 30 sq. ft. per acre, 1 to 1500, .067%. We impose another rule where sunlight has to heat the orchard floor. We remove trees to maintain shade on the orchard floor to be between 40% and 60%. This ratio will be tempered by pruning ability, and how well nut crops are filling.

A. Hedge-row trees are used to break prevailing winds off grain fields, also still wind in the nut grove to retain heat and moisture. Pawpaws and filberts, which do not stand against wind, need windbreaks. The fastigate white oaks from around Montreal are tall columns that have had no disease, hold leaves into winter, and take little space. Oaks are tall so pines and European alder are bushy to interspace, and much in use. Alder are very healthy looking, so must stand up to salt. Persian walnut tree spacing should be wide for wind to dry the orchard so space the east-west rows wide. Persian walnuts need wind to dry leaves and nuts quickly from dew or rain before walnut blight can take hold, so rotate wide spacing 90° to east-west, so West wind is not



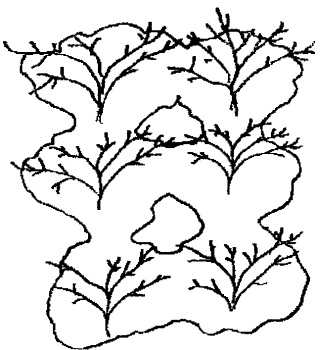


X. What nut trees are economic? We cannot directly answer this question. Nuts are imported, and sold at very interesting prices. Listening to southern pecan, almond, walnut, and maritime filbert growers. Their payback for crops has been great enough to increase acres planted. Nut kernels are treated as condiments rather than as basic food. At \$10/2.2 lb.= 1 kg. for kernels, versus \$1 per kg. for rice, only enough kernels will be sprinkled on rice to appeal. Not that nuts make you fat; studies say they don't. We will have to keep costs down, and bring along customers as our production increases. The many strange creations in our nut groves have to be sampled, harvested and used. Visitors must be educated to tell their friends about local nuts, and beautiful orchards. The planting pattern and horticultural mix must match efficient culture and harvesting. The outlook would be bright if we were also paid to develop a research station, horticultural park, heat sink, air cleansing bio-mass, and nut orchard. However, pay will rely on the market price of nuts. While we are researching varieties, growers in more sunny climates are efficiently mono-cropping. Chestnut, filbert and walnut blights link directly with freeze injury to cause crop loss, if not tree loss. These problems have diminished with new selections and methods. Look to the Guelph and Simcoe stations, Rutgers, Syracuse forestry, the internet, as well as nut growers, and nut organizations.



1. Grow filberts. People know these round kernel nuts. Apple orchards on M.26 give similar cultural techniques and economics (10 ft. by 13 ft., or 3 m. by 4 m. spacing). Hybrid filberts produce nuts of European quality, hardy bloom, and high resistance to eastern filbert blight. Growers must keep ahead with pruning and de-suckering to display fruiting stems to the sun. 10 year filbert yield 20 lb./bush/10 kg./bush whole nuts, about 3000 lb./Ac., 1500 kg./Ac.

2. Grow chestnuts. Chestnuts are grafted on sibling rootstocks. Culture is similar to apple on MM. 106 rootstock (20 ft. by 30 ft., or 6 m. x 9 m. spacing). Pruning and thinning must size trees to grow extensive root systems. Minimum growth allowed while bearing is 10 in./25 cm. on terminals. Without watering to produce this minimum growth chestnuts shrink to unmarketable size. Hybrid selections with some Chinese/Japanese/European parentage produce nuts with smooth sweet kernels as large as European. Tree trunks, especially young grafts, need painting against winter sun and freezing. Many 20 year chestnut yield 50 lb./25 kg., or about 3000 lb., or 1500 kg. per acre.



3. Grow heartnuts. Heartnuts are dessert quality nuts which can be cracked and stored with black walnuts to acquire the taste of a mild black walnut, or simply stored a long time to taste like Brazil nuts. When first dry they are very mild and are best used out of hand. They have year long shelf life, far longer than Persians and pecans. Hand cracking heartnuts is fastest of all walnuts, and without mess. Plier pressure on the edge separates the shell halves, and the kernel dumps. Spacing would be 6 m. x 9 m. like chestnut, but spraying says not mixed with chestnut, and chestnut tree shape is a cone like pine tree. Heartnut is flat like an umbrella (grape culture). Heartnuts would about touch before thinning starts. Heartnuts are terminal bearers which their tree shape, branch strength, leaf density and cluster-bearing complements. Many short terminals must appear before high production is possible. A 20 year heartnut tree produces 30 lb./15 kg., or about 2000 lb./Ac., or 1000 kg./Ac. whole nuts.

4. Plant other nuts as selections evolve. Rootstocks of black walnut should be set out to start heartnut, black or Persian walnut. The hickories (hickory, hican and pecan) use shellbark, or pecan rootstocks. Pecans might be rootstocks at dry uplands, but not usually because sizing large nuts (and pecan survival) depends on wet river flat water, so **irrigation** to upland sites must be provided.

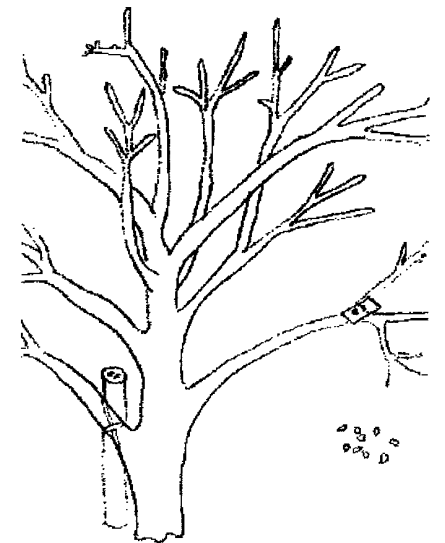
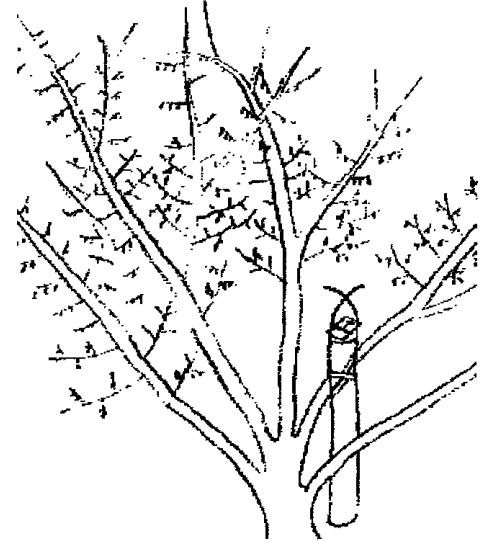
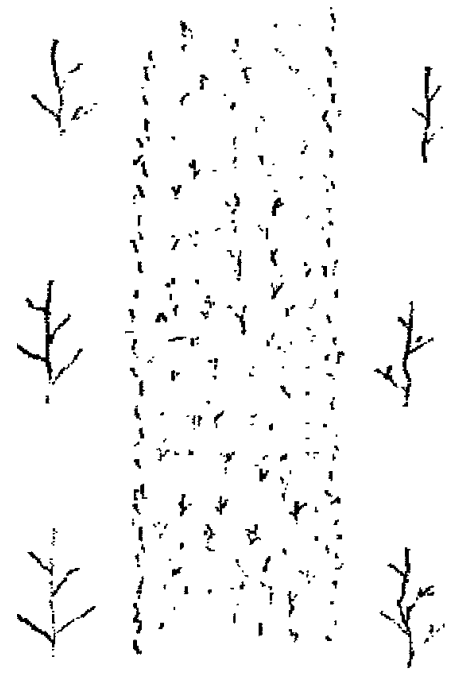
B. During the early years of a nut orchard, several intercrops should be considered, mainly where grafted or layered trees are set out widely spaced. The intercrop would be removed as the nut crop comes along. Vegetables (like sweet corn), hay, strawberries, raspberries, asparagus, and nursery stock are examples. They cannot grow near trees, or soil compaction, root shearing and tree scuffing will occur. Birds are attracted to trees, then to berries. Hay fits nicely, and is mown to use row middles. Before planting talk hay with neighbors for the best hey type, seed mix, and equipment use.

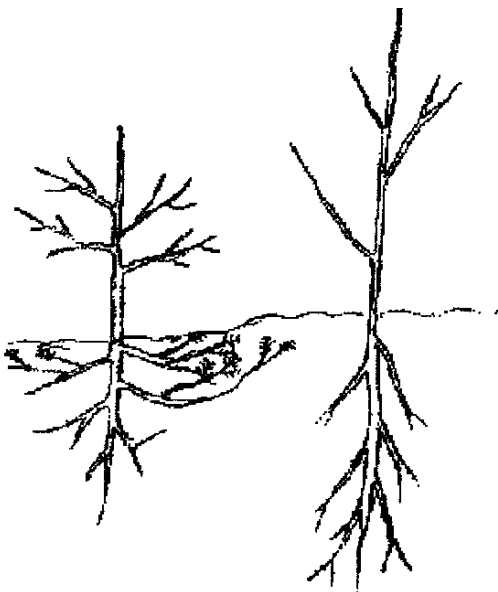
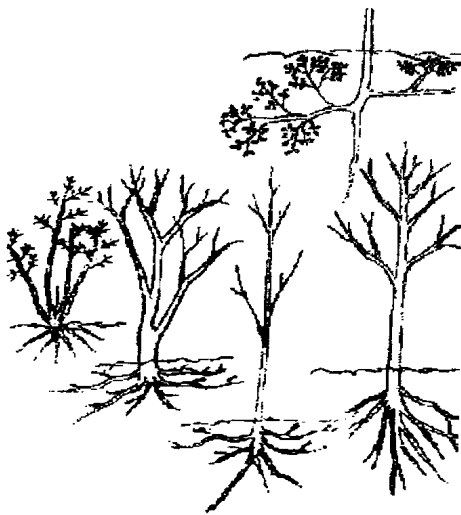
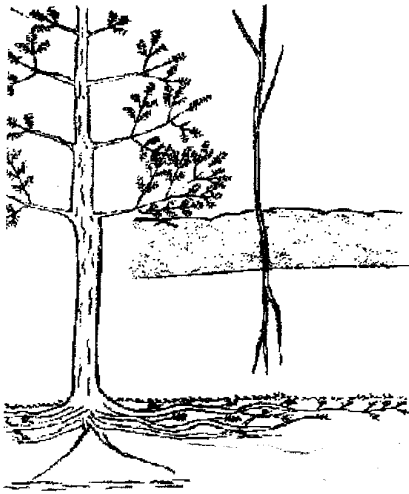
XI. Squirrels, chipmunks, raccoons, blue jays and crows put pressure on crops, and grower. Bangers (with and without lead), stove pipe trunk shields, and traps are used in the nut grove. Standard practice is to put filberts on posts and watch for them to disappear. When they disappear quickly, it is time to set a rat trap (Loop wires above the post to repel raptors from the trap.) When jays take nuts they perch, and crack on the low limb of a nearby tree. Shell litter locates the cracking perch, and shows where to locate a rat trap. Planting beds are also raided. A quickly killed cover crop of oats hides emerging nuts from birds. Filbert and Persian walnut groves need to be hunted at daybreak. Bird alarm calls, a little gore, plus propane bangers gets the message across. Squirrels jump long distances and it is almost indispensable to have hunter friends near town. However, hunting restrictions are heavy even in the countryside, so plan on invite hawks perching if hunting stops.

A. Planting seed for nursery stock was easy in beginning years, but squirrel/chipmunk/blue jay infestation is great near a nut grove. Luckily, with squirrels and birds come hawks. Try to find **open** ground which is un-trafficed by squirrels and rabbits usually because they can be caught in the open by hawks plunging out of large nearby trees. Design rows so double rows are like beds, and of orange plastic diamond safety netting can be cut, and rolled out to cover the nuts. Two rows match with three feet wide mesh strips, but usually only 5 foot rolls of fence are easy to find. One layer of net is not as good as two layers because this doubling trips up the squirrels. Mouse bait is under the netting because hawks cannot get through to the mice.

B. Sapsuckers drill into heartnut and Persian walnut bark to flow sweet sap, and catch the insects seeking sweets. Rolls of green octagonal garden netting work best against rabbits chewing, deer rubbing, and sap sucker drilling. The sap suckers start working near the ground where sap ooze is first found in the spring. Try to head them off. Sticky substances like Tanglefoot or grafting pitch can end the pecking, but needs to be renewed.

XII. Knowledge is half the battle. We share experience to promote better selections and procedures. It is fun dealing with nut growers because they are the hardiest of optimists. Each day we gain new experiences. Work to pass them on.





A. What nut projects maintain public interest? Nut gathering. Get the young ones finding nuts. Find the goodies in the nuts. Grow the nuts. Learn about the quest to restore the native chestnut. Grow resistant chestnut, and transplant to conservation areas. Find, or plant filberts, persimmons and pawpaw from select seed so your on-own-root selections provide root suckers, which can be moved to conservation plantings, or recommended to others. Select persimmons and pawpaws on-own-root, and they furnish roots for starting sprouts in damp paper in a white plastic bag in a car, or south window.

B. In the early 1980's timber walnuts were surveyed throughout Southern Ontario by the Ministry of Natural Resources. Many selections were gathered and grafted at the forestry station in Maple. This is not an on-going project, though some of the trees may still exist. Being busy, we never got these walnuts developed to become a forestry demonstration. Walnut timber demonstrations are high profile, we need a demonstration of the best-of-form local selections.

C. Native chestnut needs resistance genes against the bark blight. Genetic engineering at Eastern States Forests Syracuse (ESF/Syracuse) uses genes from common food plants, which convey resistance to native chestnuts. Various packets of resistance genes are now in the field, behind fencing, working their way through the permit process. Hybrid chestnuts need the best **food gene derived** resistances. Much testing is needed to gain multi gene resistance in chestnuts to sustain it in case resistance to some of the genes evolves. Next comes the permit for general release.

1. Nuts are used in cooking. Heating breaks cell structure to make kernels "melt in the mouth" with taste, and texture. It is the oil content of nuts that takes on food flavors in cooking. In storage nuts take on the odor of surroundings. Nuts stored with onions and garlic might do well in Chinese cooking where they are expected to bind with ginger and saffron. They also take on the flavor of fruit and spice in cooking. The mild heartnut takes on the harsher black walnut flavor while the black walnut becomes milder when they mixed in storage. The Chinese report high quality "fish" oil/omega 3 concentrated in heartnut. Heartnut has exceptionally long shelf life. Nuts are a natural unprocessed food high on the goodies list of health foods. Nut shells, bran and kernels are high in antioxidants which bind with invading oxygen to keep oils from going rancid. These same antioxidants can pass into animal tissues where they destroy free radicals. Free radicals are waste products within cells and are implicated in cardio vascular disease, stroke, the initiation of cancer, and other life shortening ailments.

XIII. **Technology will help with nut growing and breeding:** Ag robots without backaches are **so**rely needed. Dial-up microwave frost protection from satellites can eliminate many frost/blight problems. "Tricorders" should distinguish clones, siblings, close relatives, and on to confirming genes with their special traits. Already we have the internet and Google to search out from the key words to the topic of interest. I should search the main chemicals in nuts, hydrojuglone in walnuts and hickory; tannins in chestnuts, filbert, tree hazel, persimmon; annonaceous acetogenins in pawpaw.

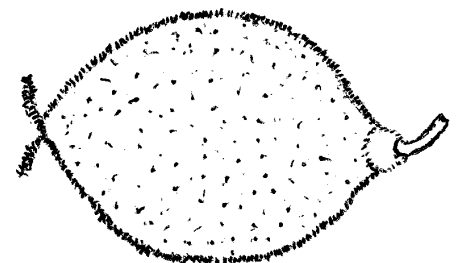
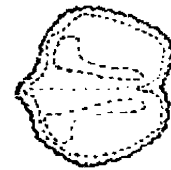
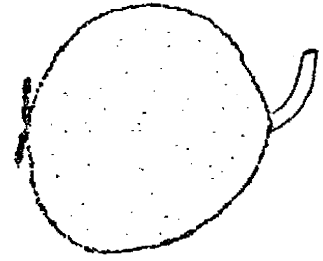
BLACK WALNUT (NATIVE WALNUT)

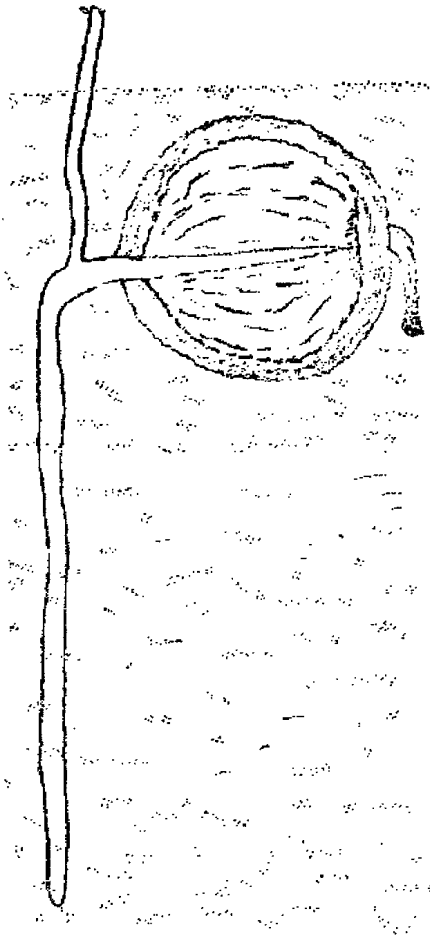
I. Black walnut (*Juglans nigra*) is a highly flavored nut and pricey hardwood:

- A. Black walnut grows in native stands south of a line from Orillia to Peterborough and through Montreal along the St. Lawrence Valley.
- B. Isolated trees are growing in Edmonton, Winnipeg and Ottawa's valley.
- C. Good seed from thrifty trees is often free for the gathering.
- D. Nuts can be harvested for some income while timber production is anticipated. Sought after selections have large kernels, thin shells and mild flavor. Long nuts that split shell along deep kernel-to-embryo slits suit hand cracking, but are not for current commercial cracking which use round hard outside shell nuts which shatter when they pass through progressively gapped roller crackers.
- E. Outdoors, under warm dry conditions black walnuts graft readily, at or above the 3 ft./1 m. height. Below 1 m. there is too much bleeding. Smaller stocks graft indoors in controlled conditions.
- F. Grass can be harvested or pastured under black walnuts due to good light penetration and beneficial shade. Walnuts raise the pH of the soil. However, red fescue and fescue type grass harm walnut.
- G. Real estate values can be increased by growing black walnut trees on odd spots about a property.

II. Limiting factors in growing black walnut:

- A. Typically, black walnut grows on rich, well-drained soil where roots can extend down at least 4 ft./1.3 m. Roots extend outward way past limbs to get in trouble in gardens, killing strawberries, tomatoes, non-native trees, and pines because pines need acid soil.
- B. Soil has to be naturally sweet to slightly acid over limestone, or liming is necessary for good walnut growth.
- C. Hulling, washing and drying black walnuts is a messy cottage operation requiring boots, gloves, protective clothing, if not a mechanical huller. Walnut stains on skin are said to ward off cancers.
- D. Custom hullers and crackers operate infrequently north of the Lakes. St. Williams Provincial Nursery buys seed nuts from service organizations, but look to experienced walnut growers for proven nuts and seedlings.
- E. Bunch disease, which might be potassium deficiency, seldom bear, so stay away from twiggy/broomy looking walnut trees.
- F. Care in pruning timber is necessary, or bark diseases will be air-borne, and can be carried tree to tree, often when pruned at the wet/cool/bleeding time of the year when walling-off and callusing are slow.
- G. Thousand canker disease (a bark borer/bark canker fungus disease) has spread from the South-West to Nebraska and Tennessee to kill many black walnuts. This is the next test of our faith in the future.





III. **Germination of black walnuts** requires fall planting, or moist stratification through winter.

A. Harvest walnuts from tall, healthy trees which grow in the region of the permanent planting. Central Ohio selections move to tougher soil/hardiness zones, where local selections may not move down the road. Crack several nuts to check filling and kernel size. Very large nuts can produce grafting stock in one season for indoor bench grafting.

B. Hulling nuts is unnecessary unless nuts are for eating. Nuts for eating are gathered every few days, hulled, washed and dried to keep kernels bright and mild. The first nuts to fall are often blank. If nuts are allowed to lay on the ground and get soaked, the pellicle covering the kernel will stain dark and the kernel takes on a harsher flavor. Dry nuts by spreading on newspaper in a dehumidified room for a week, or hang in wire baskets in airy, dry conditions until the kernels are palatable. Discard hulls and wash-water with care because juglone, the inky fluid in hulls and roots, is toxic to pines, strawberries, tomatoes, apples, and earthworms. Yet, earthworms rid oxidizing organics from soil, which plants could use directly. Juglone is throughout walnut trees.

C. Black walnuts for planting can be stratified, or planted in the hull. Hulls improve the soil. Stored in a pile on the earth under rugs, kept moist, aerated, and allowed to freeze, and thaw through the winter, the hulls are all that is required for stratifying medium. Cat, or wire protection is often necessary to keep rodents away.

D. To fall plant, lay the nut on its side; stem end horizontal. Cover with 2 in./4 cm. earth, then (not essential) 1 in./2 cm. of sawdust and enough earth to hold the sawdust in place. Where mice and squirrels are a problem delay fall planting as long as possible while baiting, trapping, and removing habitat.

E. To spring plant, follow step D in March except stratified nuts will have split open if warmed above 65°F / 18°C, and care must be taken not to shear apart the two halves of the nut. Un-stratified nuts must be soaked in aerated ice-water for a weeks or longer before planting. Un-stratified butternut will require the full summer and winter planted, to come up. Mark the rows well because black walnuts held too dry over the winter often require a year in the ground to germinate.

F. Just prior to seedling emergence, spray a contact systemic herbicide and an over-the-top selective herbicide (Roundup + simazine or equal, spraying with simazine + Solicam in fall) to kill growing grass, weeds, and germinating seeds. If the planting is small, hand weed while weeds are small (not appropriate for sod.)

G. Keep the sawdust from drying out until most of the seedlings appear. Crows and especially squirrels will dig up the growing nuts long after seedlings emerge. Baiting is a deterrent. Agway and Co-op stores sell an effective orchard bait. The mulch should have worn to 1 in./2.5 cm. because deeper mulches can host pathogens which girdle emerging seedlings.

H. When walnuts start to appear, or rabbits start digging, cover beds with two layers of orange plastic diamond construction safety net. This will trip up furry predators where hawks are patrolling. This netting should be removed at leaf drop in fall.

I. Simazine is an effective and long lasting herbicide, commonly used on nut seed, and orchard plantings. On loamy ground simazine stays within the top 2 in./5 cm. of soil. Most of the common nuts, except filberts, display rapid growth and high tolerance to simazine (and its cold season control twin, Solicam, fall applied). To use effectively, simazine, which is taken up by the roots of plants, has to go on early. There is about a month's delay of simazine between application and control. Deep rooted weeds, and hardwood seeds are seldom affected by simazine + Solicam. Also, recent spray can be washed over the ground, carried by run-off, to do damage in neighboring susceptible rows. That said, bird dropped seed of oak, mulberry and autumn olive are seen sprouting and growing in treated black walnut beds.

IV. Choosing the site for a black walnut planting should be well planned. The planting site should be a hilltop, hillside or high river bank location with a 5 ft./1.5 meter deep soil. A well chosen site has good water and air drainage. Surprise frosts on still nights are unlikely because cold air will flow downhill and be replaced with warmer air. At a frost pocket, which might be the flat below a hill, or a clearing in a forest, late leafing walnuts, and corrective pruning, and close spacing can force walnut tall, slowly. If the soil is acid and not rich enough for good plant cover, it should be worked and limed for one or more seasons to improve it. Poor soil aeration and drainage must be improved by ditching or drain tile. Planting walnuts mixed with pines is highly beneficial to the walnuts. The pines give wind protection to the walnuts while forcing them to grow tall in full sun, producing good log conformation. The pines are eliminated by walnut roots (high pH from walnut roots) as they grow into each other. Try to find sites where walnuts are already growing. Start looking where walnuts are seen from the road. A search of the nearby bush can yield walnut trees which have been naturally seeded. Releasing a stand of walnut seedlings will be well worth the effort for logs.

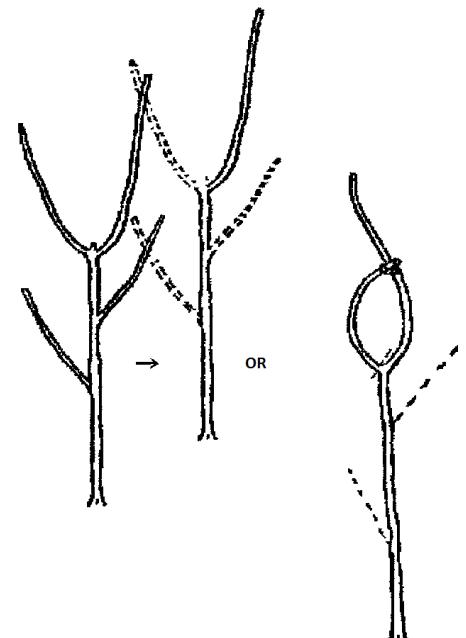
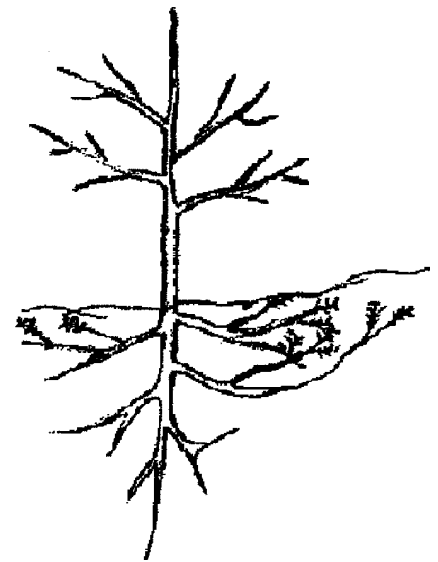
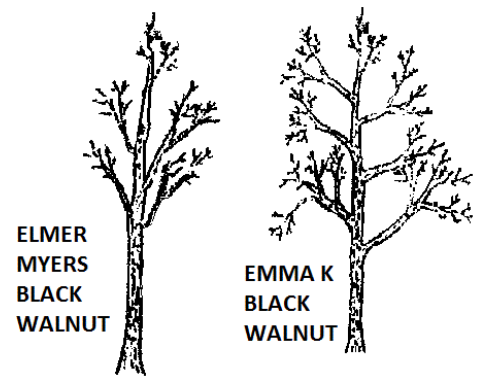
V. Improving timber production in walnut stands is a short cut in log production:

A. **Release:**

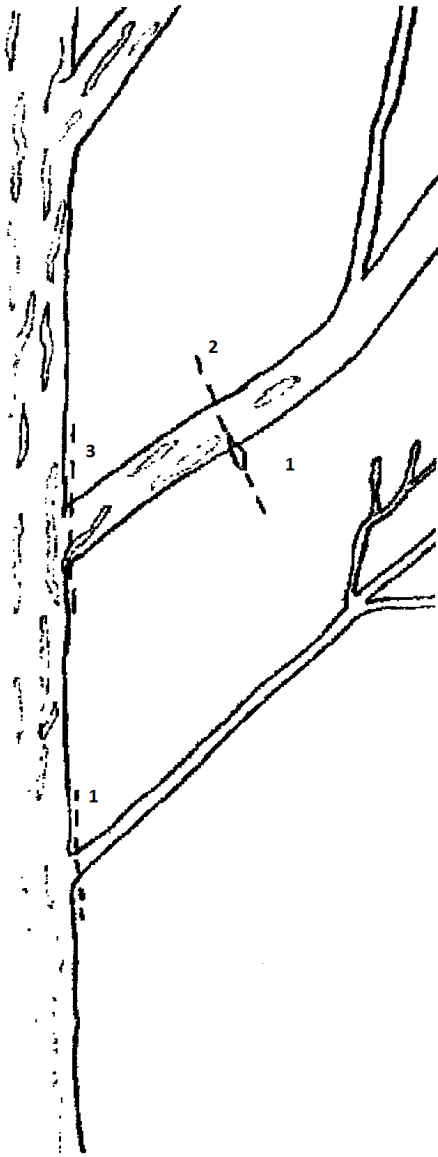
1. Release existing trees by removing vines from them and cutting back competing vegetation. Remove only enough brush and worthless trees to stimulate the walnuts to full growth because total growth will be faster in a clearing than in the open. Girdle weed trees without removing them. Black walnuts are seldom debarked by chewing, though they are rubbed raw by deer horns. Don't produce a park too early.

2. Sell lower value trees for timber and fire wood while periodically clearing to keep young and higher valued trees growing rapidly.

3. Fell trees carefully to avoid injury to trees which remain. Pile slashings, rather than burning them, to produce cover for wildlife and enrich the soil. To return slashings to soil rapidly, cover them with earth. Also, leave a few hollow trees on the edges of timber for use by wildlife. If a hunting camp is an option, white oak, red oak, and (soon-to-be-resurrected) native chestnut should be in the planting mix for high quality mast production.



B. Prune black walnut:



1. Prune all dead limbs. Double cut to prune all branches greater than 2 in./4 cm. diameter so the heavy limb drops clear with no splitting. (In the first cut the branch is detached beneath, then above, and dropped away from the trunk to release its weight without tearing the trunk. The second cut leaves the branch collar at trunk to promote healing.) Drought periods make a poor pruning injury season because trees cannot drown the borers with sap flow, but sap flow is not good either because it introduces pathogens. Current thinking is to prune in late summer toward winter when fungi and insect pressure is low, leave wounds bare with no dressing. Most wound dressing seems to be superficial, and only encourage rot. Look for fungicidal spray for wounds and equipment if pruning late fall into spring.

2. Try to confine pruning to the removal of lower limbs, shaded limbs, poor crotch limbs, and divided trunks before they reach 1 in./3 cm. diameter. Annual pruning may be required to develop a 16 ft./5 m. log. Remember that reducing a tree's leaf area slows its growth. Better advice may be to do no pruning (minimum), relying on close 7 ft./2 m. spacing. "Corrective" pruning has demonstrated how easily bark disease can be carried tree to tree in state and corporate plantings. Thus, disinfect tools whenever a dead or diseased limb is cut. A 5 % chlorine household bleach dip is often used, 12 tablespoons per gallon (3 tablespoons per liter).

3. Correct a double leader in a young tree by crossing the leaders and taping them at contact. Remove the growing portion of the less dominant leader above the tape. At the start of the next growing season remove the rest of the less dominant leader.

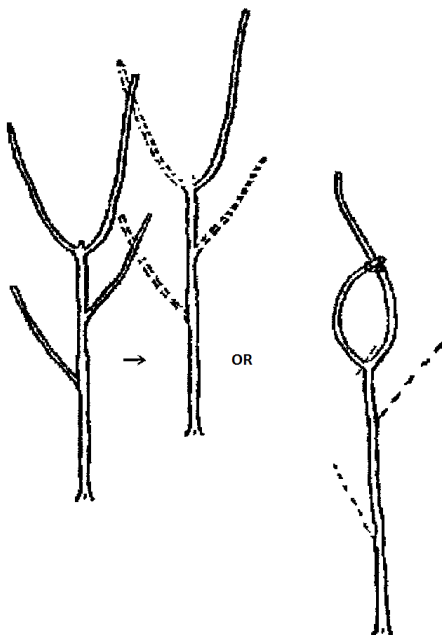
4. Always remember to bring a saw when pruning the walnut stand. Use saws, saws on poles, and shears for pruning. Axes and corn knives lead to reckless injury.

C. Protect black walnut:

1. In pastures it may be necessary to fence off young walnut trees to prevent browsing, rubbing, and soil compaction over the tree roots. Frequent grazing by heavy animals compacts the soil, thereby reducing the air-water balance at the tree roots. Deer rubbing and browsing can be ended by planting small seedlings in tree growth tube shelters if shelters are 6 ft./1.5 m. high and on a strong stake. Rather than a shelter tube, a tube of octagonal green/brown plastic garden fencing is better, but must be loosened, removed at a 6 in./18 cm. diameter tree.

2. Cut grass and weeds to prevent fire damage. Plough, and disk lanes to prevent the spread of grass fire. Use Roundup + simazine (Solicam in fall) mix of herbicide to clean spots around young trees. Do not let Roundup drift onto tree foliage, or green bark.

3. Attach no metal to trees, such as; staples, fences, nails, tags, signs, iron posts; also mis-directed bird shot, and slugs.



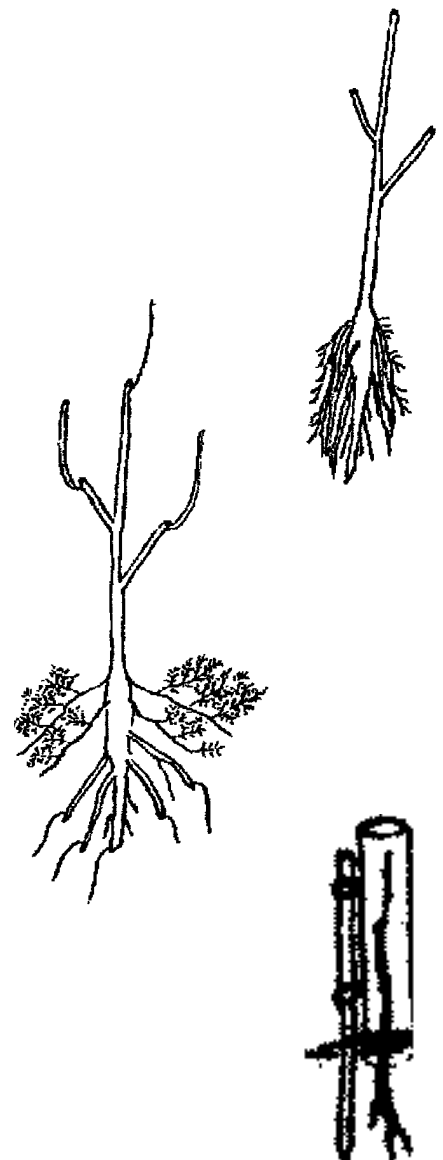
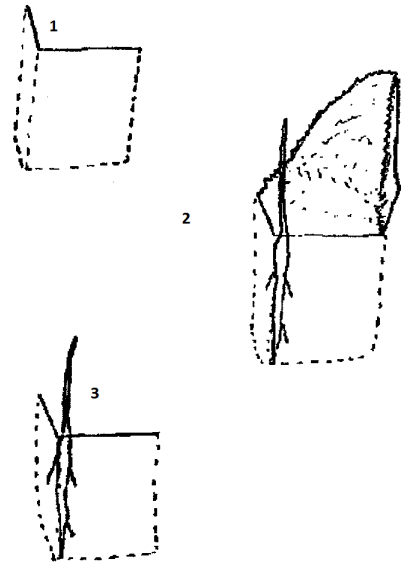
D. **Step planting** one year black walnut seedlings is a proven method of establishing a stand.

1. **L planting method:** Kill sod and weeds in a 4 ft./1 m. spot with Roundup + simazine a half day before planting.
2. Lift a 12 in./30 cm. deep wedge of sod by two spade cuts, one just touching the other, and forming an "L" on the ground. Do not detach the third side of the wedge.
3. Insert the seedling down the apex of the "L".
4. Replace the wedge of soil as you found it, stepping it firmly into place.
5. Stake a tree tube shelter over the seedling, over-topping it by 4 in./10 cm. Tap the shelter into the ground to avoid mice tunneling underneath. In a conservation planting this shelter is not likely to be seen above tall grass during summer mowing. Better use a 5 foot stake, and shelter as we did at the Gowanda, NY chestnut planting. Group planting is strange. All attempts are worthwhile, but my work around was to get pails of dirt, and resurrect many burials, which looked like trees in the bottom of holes.

VI. **Transplanting and maintaining** black walnuts:

Most heartnuts, their hybrids, butternuts, Persian walnuts, and black walnuts which have become respected varieties are now grafted on black walnut rootstock. Some of our advice is gold plated for seedlings, but not when trying to get expensive grafted trees started.

- A. After grass has grown out 4 in./10 cm. in the spring, kill sod in a 7 ft./2 m. spot with Roundup + simazine. Spray at least half a day before digging.
- B. Dig the planting hole broader and deeper than the extended root system to be planted.
- C. For a one meter high transplant, mix approximately one kg. of bone meal into the planting soil. (Digging and mixing in the bone meal or granular fertilizer the previous summer is highly effective.)
- D. Spread the root system and trim off dead and badly injured roots. Roots greater than 1/2 in./1 cm. diameter, which have torn ends, should be pruned to smooth cut wedges. Do not let the roots dry off. Roots which look grown together, like straws on a broom, will resist spreading, but must be separated, then separated by backfill earth. Packing, stacking causes this unnaturally congested root mass.
- E. Place the root system in the hole so that the root crown is 2 in./5 cm. above the original ground surface.
- F. Filter in the planting soil while spreading the root system. Remove weed roots and grass clumps from the planting soil as you come upon them. A fibrous root system on your transplant indicates a healthy, well nourished tree. This tree can be ruined by wadding together the roots. Rather than wadding, it would be better to trim off some of the hair roots. Inexperienced planters often need to be supervised.
- G. Tug on the stem and tamp to consolidate the soil while keeping the roots extended.
- H. Water to help consolidate the soil, but don't flood out the filtering-in of soil and tamping operation.
- I. After all the soil is replaced, top-off with a 6 in./15 cm. mound of brought-in soil, mulch with clear plastic film in spring and wood chips in summer if you have them (avoid insulating a cold soil), no contact between the stem and any mulch. No root crown is visible because the 4 inches of settling is to be expected. Settling that causes a pocket at the root is a disaster when mice nest/eat there.





J. Stake a tree shelter cut to over-top the tree 4 in./10 cm. Tap it into the ground a few centimeters so that mice do not enter.

1. Alternatively, wrap the stem with a tube of plastic octagon garden fencing laced with wire ties inserting the tube 2 in./5 cm. into the ground.

2. If wilting occurs after sufficient watering (maybe at the end of week after a 5 Gal./ 20 l. pail) trim off drying leaves.

3. Water as often as is necessary to keep the bare-earth-mulch area from drying out. Soak the ground at each watering to get the water down to the roots. Soil, fertilizer, and water should be the pH 6.5 for walnut.

K. Use no granular garden fertilizer salt in the replant soil. Begin broadcasting 2 lb./1 kg. of granular fertilizer per inch/ 2.5 cm. of tree diameter away from the trunk and well past the branch drip-line. Renew this broadcast on a two month cycle (any time the leaves go from dark to pale) through the growing season into August (some say September). Broadcasting onto wet grass helps by burn/chemical hoeing.

L. When weeds return, hoe and spray with simazine. Grass sod is anti-walnut. Leaf health is far better where grass is eliminated under walnut trees (and under nut trees subjected to curculio predation.) Nature uses a bramble mulch, but that makes our life too difficult.

M. In future years maintain a 7 ft./3 meter spot of bare soil around the tree. Spraying simazine + Solicam once in the fall at frost has proven effective, but Solicam costs, and **simazine is effective on walnut**.

N. Avoid pruning by crowding the walnuts with pines and other walnuts. Seed and seedlings from special seed trees consistently produce upright trees. Planting close allows for quick removal of deficient/malformed trees. Prune to remove dead, malformed, and bark pinching branches, and those temporary before attaining 1 in./3 cm. diameter branches within the length of the desired log. Avoid disease spread by late summer pruning.

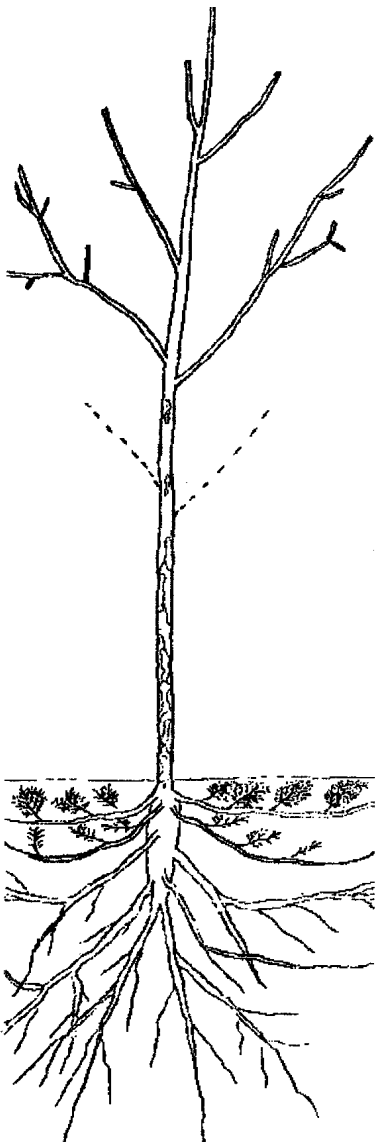
O. Once nut production is underway, expect to fertilize each year with 1000 lb./500 kg. of 12-12-12 fertilizer per acre. If health or production falters, determine fertilizer supplements by leaf analysis. Leaf analysis is tricky due to the ability of leaves to concentrate the minerals tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding. Mulching and keeping an active soil flora and fauna frees up bound minerals.

P. As crowns touch, 90% shade pattern in timber, or 70% shade pattern in nut orchard trees, trim or remove black walnut trees. Remove defective trees, and trees interfering with more valuable trees.

Q. Before nut harvest, cut grass, and rake, or shred debris which can hide nuts. The first nuts down are usually blank and should be treated as debris. Clean harvest all nuts to eliminate the pests they host. Mechanical harvesting usually requires rolling the bumps out of the soil when it is internally moist, but not dented by turf tractor tires.

R. Trees producing mostly blank nuts will probably be removed. The cause of blank nuts is usually root injury, red fescue/too much grass, foliar disease/anthracnose /bunch disease causing mid season leaf fall, or calcium/potassium/zinc/iron deficiency.

VII. Black walnut cooking makes use of the high flavor of the kernel which is unchanged by cooking. Cookies, candies and ice



cream retain the black walnut flavor, and "black walnut" in their name. Black walnut selections for hand cracking are chosen for their production, ease of cracking and mild flavor. Carefully substitute (be restrained in quantity) black walnuts for Persian (English) in a recipe. Half the original volume of nuts is replaced with black walnuts without overdoing the walnut flavor. Also, the mild English walnut is used to accumulate spice and fruit flavors in its oil.

A. Harvesting and storing black walnuts is one of those jobs left for the little red hen. The reward is a long way off. First nuts down are usually empty (Squirrels only take well filled nuts.) Pick duds up with debris for disposal, likely worm infested, so be sure they are milled and mulched. The rest of the nuts should be gathered weekly, after wind as they fall. As the hulls turn from green to yellow, and on to brown and black, there is a good chance that the kernel will be moistened. The pellicle of the kernel will darken and the kernel will become strong tasting. A solution is to use tree shakers, and rolling coil harvesters to complete the harvest quickly. Nuts for eating or shipping should be hulled and dried. When the hulls turn yellow, they are easily stepped off the nuts. Boots and gloves are worn for protection against the inky walnut juice. Handy people have constructed hullers from 100 pound propane cylinders, using chain on a shaft and pieces of rubber tire for bumpers to ricochet nuts along the inclined cylinder. Constructed properly, the hulls break free, cease to travel, and fall through the screened bottom of the cylinder. A spray of water can be directed in so that the nuts emerge washed.

1. I was a bit hard on juglone, probably remembering the black fingers, and black welts on legs from green walnuts in pockets. Google for juglone as a nutraceutical increasing a basic pH body chemistry to counter leukemia, and other cancers.

B. A huller made with the front wheel of a front drive car is less work to construct. It works driven with a tractor's power take off, mounted on the hitch, and scuffing along a track made of reinforcing bars. The tire-to-bar gap is adjusted by tire air pressure.

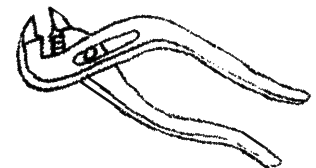
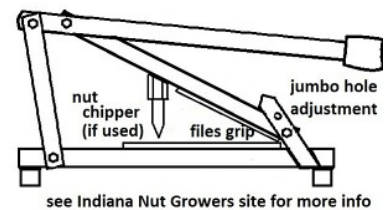
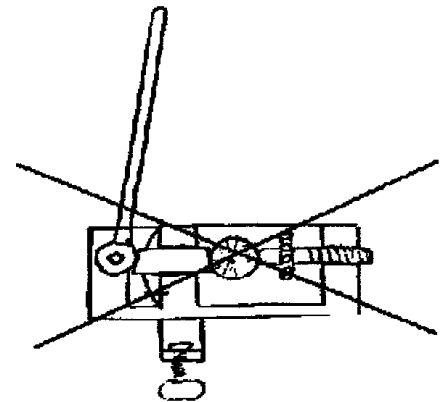
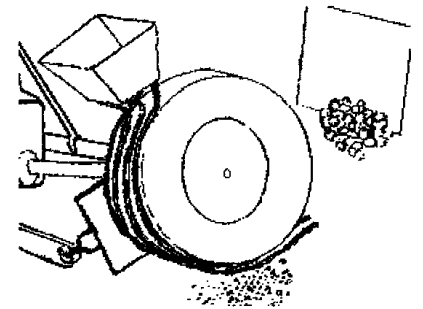
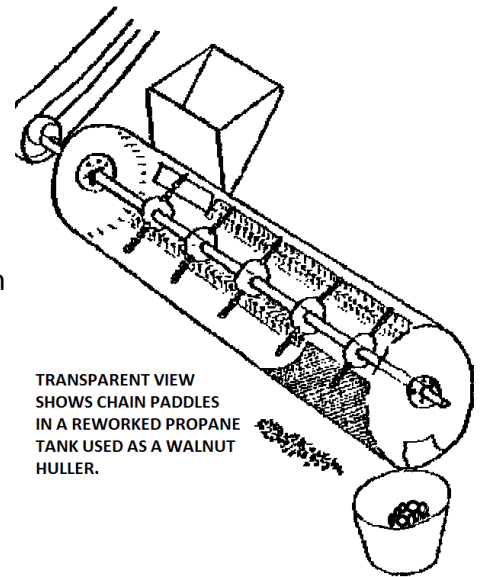
C. Drying nuts may be by spreading on newspapers in a dehumidified room, laying in screen trays through which dry air is blown, or placed in onion sacks for storage in airy shelters. Drying takes from a few days to a month depending on the method. After drying, walnuts should be stored in a cool dry place, and protected in airy tins from mice.

D. Cracking black walnuts in Ontario/NY is most often a hand operation using a hammer or a vice. Walnut cutters cut shell to clean up trapped kernel so that kernel extracting can be completed in the kitchen.

E. In the central U.S. commercial walnut crackers buy and process black walnuts by the ton. Flower mill rollers are progressively gapped to fracture shells of seedling walnuts well enough that many walnut kernels are gathered in quarters.

F. Hand walnut crackers sold for mounting on a table or work bench. They use a 16 in./40 cm. lever arm to easily crush shells without advancing the jaw enough to injure the kernels. Careful cracking will often produce kernels in quarters. A several step method for use on walnut cultivars uses the jaw cracker followed by clipping the center post of the shell with electrician's clippers to remove the kernel in quarters and halves.

VIII. After extracting, kernels should be packaged in sealed plastic, and frozen until used.



IX. Spacing black walnuts is based on spacing observations for productive fruit trees growing commercially under Lakes' Region conditions:

A. The most fruit are produced at the ratio 1:1500, .067%, butt area 30 sq. ft./Ac., which should also produces the most nuts. (approx. 50% noon shade on the ground)

B. Doubling this ratio produces the most fiber. (approx. 70% noon shade on the ground)

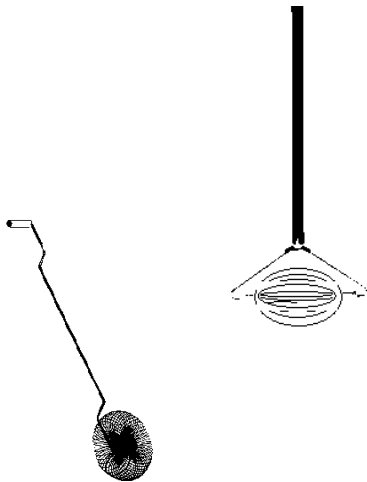
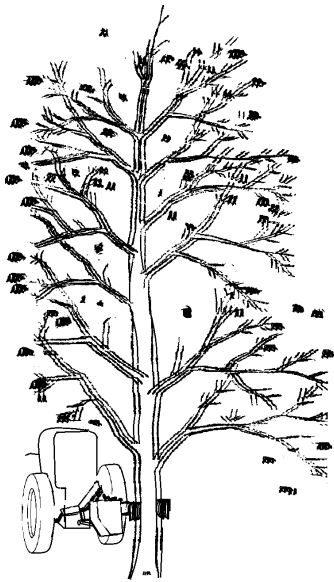
C. Decline in both nuts and fiber production is uneconomical and indicates stress injury to the trees.

D. Tree spacing has to increase with time due to growth competition. This dovetails with the need to sort out selected seedlings. Odds are that one in a group of ten seedlings, from exceptional parents, will be exceptional enough to be made permanent.

E. Tree spades are available to move large trees without transplanting shock. These spades could be used to move selected trees rather than chopping them down, though expensive and unnecessary except for super trees. Large trees droop, and close gaps in the canopy in only a couple years.

F. The years-until-maturity, and the production rate of black walnuts, are slower than fruit trees, but walnuts are much longer lived, and their logs are much more valuable.

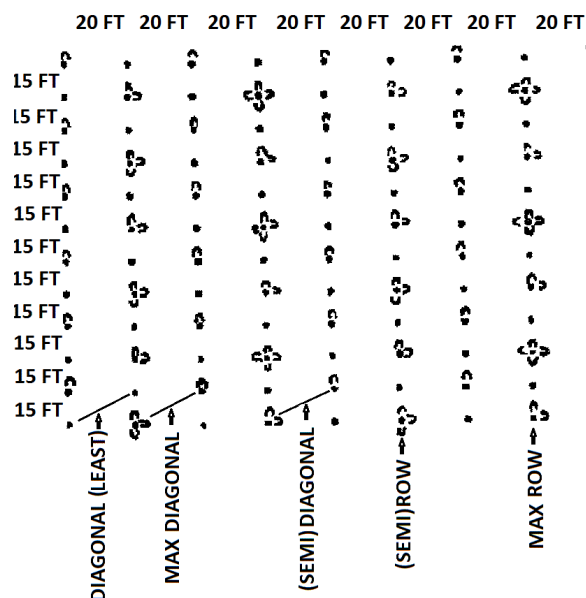
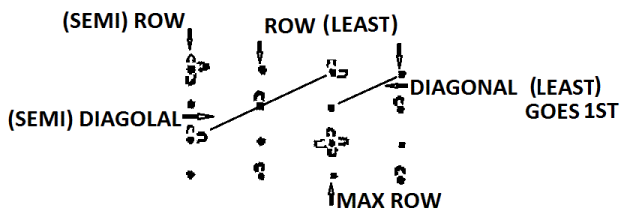
1. Black walnuts will shade each other without the rapid decline experienced with most other hardwoods. Reasons for this ability to tolerate crowding are extensive root systems that efficiently mine the soil, and open foliage that does not produce heavy shade. Increased shading of the ground, which harms grass, helps walnut. Shading the sides of walnuts is beneficial during their juvenile stage of rapid upward growth because shading encourages walnuts to grow tall. Reduction in the nut crop is slight because black walnut nuts are formed at the ends of short upper branches of young trees.



BLACK WALNUT ORCHARD - SPACING FOR THINNING TO 80 BY 60 / 1 TREE ON 4800 SQ FT

PERSIAN/BLACK WALNUT / PECAN / SHELLBARK HICKORY / HICAN / HEARTNUT HYBRID	BLOCK FT X FT	LAND AREA SQ FT	NUT TREE THIN DIAMETER,		TIMBER TREE THIN DIAMETER,	
			"START DENSITY" AT 30 SQ FT / Ac LIMIT CM	"START DENSITY" AT 30 SQ FT / Ac LIMIT INCH	"END DENSITY" AT 60 SQ FT / Ac LIMIT CM	"END DENSITY" AT 60 SQ FT / Ac LIMIT INCH
1ST THIN	20 X 15	300	15.7	6.2	22.1	8.7
2ND THIN	40 X 30	1200	31.2	12.3	44.2	17.4
3RD THIN	60 X 45	2700	47.0	18.5	66.3	26.1
4TH THIN	80 X 60	4800	55.4	21.8	88.4	34.8

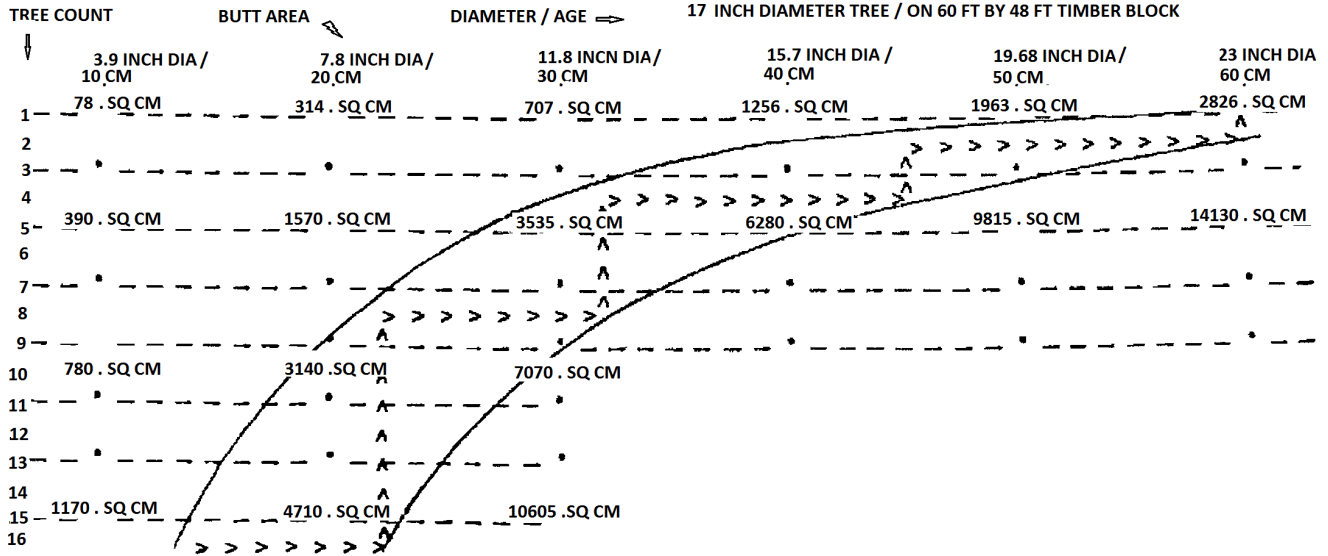
16 BLACK WALNUT TREES ARE THINNED TO ONE TREE, 1 TREE ON 4800 SQ FT / 80 FT BY 60 FT.



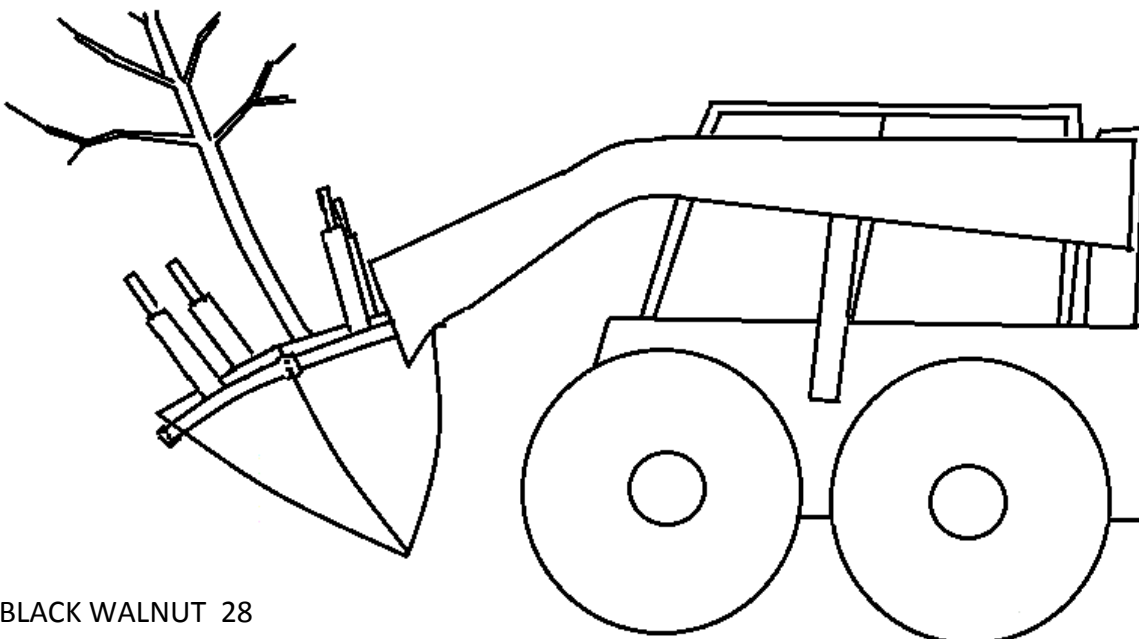
WHEN YOU NOTICE THE FOUR LEAF TREES ARE MAX, YOU SHOULD KNOW WHERE THE PERMANENT TREES ARE.

- 1ST THIN REMOVES DIAGONAL (LEAST) 8 TREES GO
- 2ND THIN REMOVES ROW (LEAST) 4 TREES GO
- 3RD THIN REMOVES (SEMI) DIAGONAL 2 TREES GO
- 4TH THIN REMOVES (SEMI) ROW 1 TREE GOES
- MAX ROW BECAME PERMANENT 1 TREE STAYS

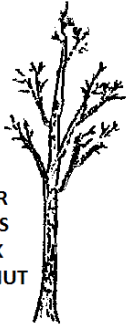
16 TREE BLACK WALNUT SPACE THINNED TO 1 (SPACE 80 FT BY 60 FT/TIME 10 YR TO 60 YR) IF GROWTH RATE IS 1 CM PER YEAR,
 12.5 INCH DIAMETER TREE / ON 60 FT BY 48 FT NUT BLOCK
 17 INCH DIAMETER TREE / ON 60 FT BY 48 FT TIMBER BLOCK



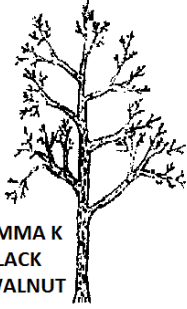
2. The thinning plot, drawn above, is constructed by plotting the best fruiting ratio, 1/1500 and best fiber production ratio, 2/1500. Through the years the typical planting area, containing initially 16 trees, is cleared until one selected tree remains. The maximum diameter of a productive black walnut looks to be 24in./60cm., 9 trees per acre. Trees were spaced closer in north-south rows to moderate west wind, speed application of pesticides, and ease machine movement and intercropping between rows. Pine trees add to wind moderation, grove heating, and pine aerosols counter diseases and pests to some extent. Planted between walnuts, pines will force walnut straight and tall, and if trimmed, could be sold as Christmas trees, or left to the killing action of walnut juglone (5-hydroxynaphthoquinone.) Foresters recommend planting pine trees on 3 ft./ 1 m. centers, then planting walnut seedlings on 6 ft./ 2 m. centers when pines are 3 ft./1m. high. Google for Christmas tree July pruning.



ELMER
MYERS
BLACK
WALNUT



EMMA K
BLACK
WALNUT



X. Black walnut timber is in limited supply, and is sure to retain its value if enough quantity can be harvested to sustain an industry. Walnut is extremely crack resistant with good weight to strength ratio, making it the "gunstock wood". Because of its crack resistance and beautiful figure pattern, black walnut is unexcelled for veneer and cabinet wood.

A. Some general rules in **selling black walnut** are:

1. Investigate the market by contacting the Ministry of Natural Resources, and logging contractors. As walnut becomes more scarce, few people will be in the harvesting business. You may receive only one bid. The government forester may be your only source of a second opinion.
2. Typically, you should sell the standing timber because the logging contractor knows how to cut logs of the highest grade, and for the highest total value.
3. Not all walnut trees are increasing in value. Some, due to injury, are decreasing. Given a good bid from a good logger, these should be sold and cut.
4. Sell trees of 18 in./45 cm. diameter, or larger, unless:
 - (a) the tree is crowding a more valuable tree;
 - (b) the tree is too defective in trunk to continue;
 - (c) the tree is injured in the top and has dead and dying branches.
5. Many large walnut selections are prized by their owners. Sentimental value and the expectation of nut crops keeps these trees from the logger. Each year they may increase in value. There is the fault of a yard, or fence-line tree; no one will believe there is no metal in it. Try to interest wood carvers to select the best crotch wood.

XI. Propagation of black walnut selections is by grafting. Valuable seed trees, nut cultivars, and curly wood trees are sought after. Graft unions are placed near the ground level (thus bench grafted, and later transplanted because field grafting of walnut is more successful above 1 m.) Graft low because the union usually continues a mark which is best left in the stump. This will surely happen with the curly walnut; Lamb, etc. Grafting at ground level causes too much bleeding, and moldy unions, if done in the field.

A. Black walnut selections can be grouped according to tree form, nut qualities, or tree health, and cropping. We chose varieties like Elmer Myers in timber tree form because it is strikingly consistent orchard to orchard, and season to season. Tree form has more meaning for orchard grown trees than for forestry due to production needs and pruning against wind damage in orchards. The close spacing in forest plantings forces uniform straight growth.

1. The tall trees, requiring little training to produce a single leader and sound branching: Elmer Myers, Clermont, Kwikrop.

2. The trees that need some training: Emma K, Sparrow, Thomas, Vandersloot, Burns, MRS, Bowser, Lamb Curly, Sauber

3. Trees that need training: Ohio

B. High quality nuts usually are found under Elmer Myers, Emma K, Sauber, Hambleton, Bowser from Iowa, Rohwer, and Ohio. Even these will take a rest, and not bear the year after a heavy crop. Elmer Myers and Emma K have the most ornamental foliage which likely produces their yearly crops. Sauber bears once every two years, and it has terrible looking limb sockets that seem to hold on nothing is trimmed. **Do not trim** its limbs trying for more timber, and Sauber will carry its bushy head like Ohio, producing lovely nuts with few torn limbs. Trim Sauber to look like E.Myers, and it will blow apart. Emma K nuts have the thinnest shells, which are easily cut for kernel extraction. Much of Emma K's crop hangs on internal branches which still get a lot of sun on their short fruiting spurs. Emma K, MRS, or Sauber might be classed "desert quality" because of their large mild kernels.

XII. Projects with black walnuts:

A. Leaf health is poor in many black walnuts. A lot of the poor health is due to growing in grass, especially fescue. Some poor leaf health is in the varieties chosen. There are upland and lowland walnuts; just as there are upland and lowland hickories. Emma K nuts look most like the lowland shellbark long flat nut, and has long lived leaves. These lowland walnuts should be surveyed and selected.

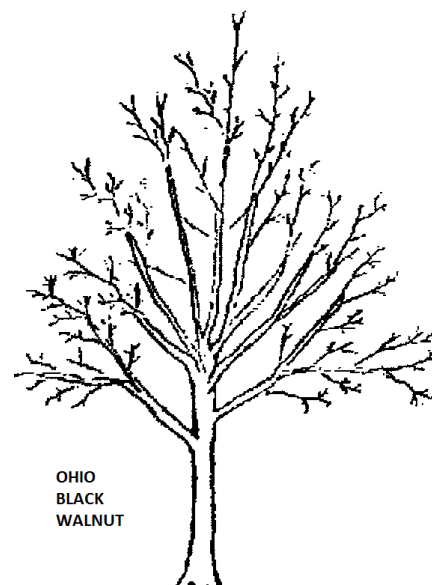
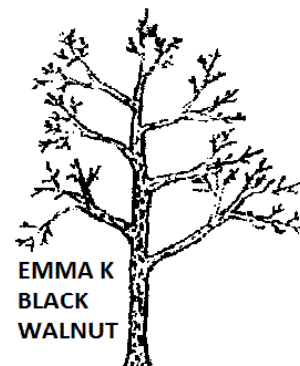
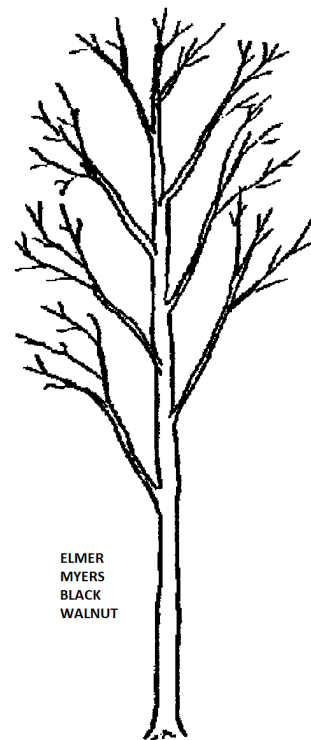
B. The health value of black walnut oil needs advertising.

C. Survey and select seedlings of named black walnut selections.

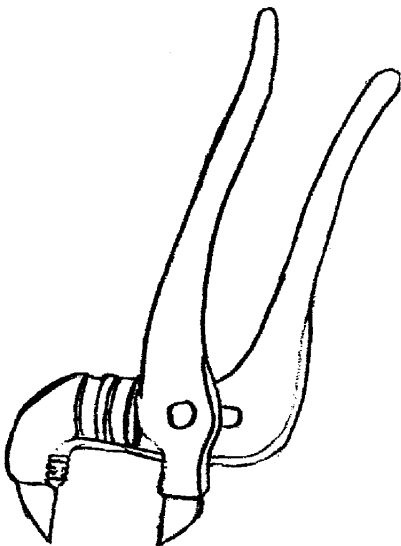
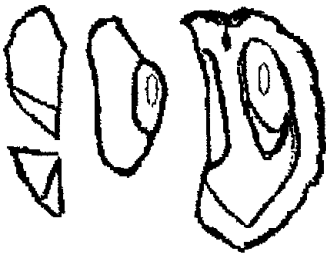
D. Identify sources of rapidly growing seedlings which produce upright trees.

E. Demonstrate inter-planting walnuts with Christmas trees.

F. Find more Emma K types that are long nuts with deep kernel to embryo slits, which break apart in end cracking. Less long, but with the same long kernel to embryo attachment slits are MRS and Sauber, also several Emma K seedlings with long extended nuts.



BLACK WALNUT CUTTER



I. Black walnut shells are hard and brittle. Even the relatively thin shells on Emma K., Clermont, and Elmer Myers require the force of lock pliers for cracking. Then they pop and shell fragments are scattered. Because each of the four kernel lobes is surrounded by shell, initial cracking often causes all four quarter kernels to be crushed. The better method is to cut the walnut in two along its suture, the line dividing the shell halves. The shape of an owl's face appears on each half. Nipping above and below each "owl eye" releases each quarter kernel. A quarter kernel from a good black walnut is usually as large as entire kernels from typical hazels, hickories and northern pecans.

II. Gaston Fornes, P.E. from Charlottesville, Virginia invented and patented the "Squirrel Tooth" Nut Kernel Extractor. Held in one hand, it is easy, fast, safe and clean to use. By cutting rather than crushing, the nut divides smoothly so that the few shell and kernel pieces remain in the hand that holds the nut. The Fornes method of cutting is good. Large, long nuts are hard to fit in a Fornes cutter. A tube cutter used to ratchet shut and cut plastic tupe is a handy walnut cutter. Here is a home made walnut cutter for cutting thin shell black walnuts.

A. There are rough cutters that serve as nut cutters. Electrician's wire cutters will nip clinging shell from bound kernel. The jaws of a 10 in./25 cm. channel lock pliers can be ground down to cutter nibs:

1. Thin the jaw ends to 5/8 in./1.5 cm. by grinding on a 6 in./15 cm. grinding wheel. The jaws are held closed during this first step so they match, cool each other, and are easier to dip in cooling water.

2. After the jaws are thinned to .5 cm. by stroking the wheel, cycle in and out along the line of the jaw teeth, thinning the teeth portion of the jaws the most, until the groove has removed most of the teeth, keeping much of the four ground faces flat, and equal.

3. Open the jaws and grind each "nib" to a wedge blade. Leave the teeth a noticeable thickness, not yet a knife edge, which meets on closing.

4. Produce a knife edge on the teeth by a hand drawn stone or file. Knife edges will no longer stop each other on closing, but usually stop at each other due to the jaws closing on each other where they still have thickness.

5. About 1/3 in./1 cm. of square jaw remains on the "grab."

B. Be warned that cutting on an angle to the nut shell will cause a slip on the nut shell, and the pliers are no longer under control. Incorrect cutting with a Fornes black walnut cutter tool is much less possible, but it is still a tool for grownups. Channel lock pliers, and vice grip pliers can injure fingers. This is not a pecan cutter with wide hollow nibs to be surround by fingers, to be dragged into the sides of the pecan. Pecan cutters nip the ends, and sides off pecans by dragging the nibs against the side of a pecan until they catch, and nip off shell by squeezing like pliers with the other hand. A black walnut cutter has to **cut like a wire cutter into the flat surface of shell**, either directly across the nut at its suture to divide the nut, or below the "owl eye" to release kernel. If the shell is cut at a slant the nibs can slip unpredictably, and do finger damage.

CHESTNUTS

(Native, Oriental, Hybrid, American, Chinese, Japanese, Korean, Manchurian, European, Italian, Marrone, Spanish)

I. Sweet chestnuts are Ontario's first, large scale, nut crop. The most successful trees are Chinese chestnut, *Castanea mollissima*, many from near Geneva, NY. Other good chestnuts are hybrids of the Chinese chestnut crossed in complex hybrids with European, *C. sativa*; Japanese, *C. crenata*; and the native American species, *C. dentata*.

A. Observations at Vineland Fruit Station indicate that several Gellatly selections crop productively in Niagara. This led the McCully Family of Chatham, Ontario to go into chestnuts commercially with seedling Chinese.

B. Hybrids of Oriental chestnut, pollinated with native, rival the Vineland trees, plus they ripen nuts in mid-September (as does Layeroka).

C. The most northern reported chestnut is a native growing in Sault Ste. Marie. Others bear in Montreal, and Maine.

D. Native chestnut soil is blueberry soil much like tobacco land. Chinese and any large nuts need pH 6.5 soil with calcium in the subsoil, but likely need added carbonate leaf sprays due to poor internal calcium transport.

E. The hybrids recommended for north of Lake Ontario resemble natives. Hybrids with native are timber trees, producing a 1 in./2.5 cm. minimum size commercial nut. Nuts are roasted. Chestnut flour is gluten-free.

II. Limiting factors in chestnut production are:

A. Current propagation of chestnut is by seed and grafting. Graft failure rate, after transplanting, is discouraging compared to seedlings.

B. Planting sites have to be well draining and moderately acid, or the chestnuts develop root infection, become chlorotic and succumb to winter injury. Organic matter in the soil often causes this same reaction if it is in the first stages of decomposition.

C. Chestnut bark disease, blight, is widespread, and a fungal plague to all native and European chestnut, and their hybrids. Even in China most chestnuts suffer with the blight although being pure Chinese. The Henry Chinquapin (*C. henrii*) from China has better blight resistance, but is frost tender.

D. No chestnut is immune to chestnut blight, but in many the resistance is strong enough that the infection is eventually walled off, seldom permanently. The resistant chestnut recognizes the canker is an infection, and call on callusing processes to limit it. The same process is heightened in Gene Modified (GM) *c. dentate* ESF Syracuse test trees now growing under permit. Hope says the walling-off will be quick, making a small canker to be covered with callus, and eliminated.

E. Chestnuts require cross pollination. Isolated trees produce only 3% to 5% filled nuts.

F. Biological control of the blight, using blight's hypovirulent form, is proving difficult, requiring much hand labor.

G. Chestnut weevil has to be kept from the area, or by 3 Sevin (carbaryl) sprays at 10 day intervals near harvest before burs open.

H. Calcium has to be in summer spraying, or the larger nuts break down.

III. Germinating chestnuts is very successful. Nuts should be fully matured on the tree (which depends on the season), kept from drying (which depends on prompt gathering), and directly seeded or refrigerated/kept humid at 30°F /-1°C. Once the nuts lose moisture, becoming spongy, they soon mold when re-hydrated in planting. Nuts cured for eating



are in this spongy condition. Immersion in cold, damp, oxygen rich earth often revives them, likely because they germinate while spongy.

IV. Germinating chestnuts:

A. Harvest chestnuts promptly, before they dry.

B. Refrigerate in a ventilated container in high humidity until you are ready to plant. To spring plant, store the chestnuts like seed potatoes using less protection against freezing, or sprouting. An unplugged refrigerator in a root cellar, which is temperature regulated with jugs of water and ice to stay near freezing, cycling slowly from humid to frost. After losing some moisture chestnuts can endure slight freezing and thawing depending on their higher sugar content with water loss, and the rate of freeze or thaw, slightly frozen before more frost as squirrel planted nuts.

C. Peat moss is the typical mixing medium for over winter storage. Put freshly harvested chestnuts into air dry peat moss and check these after a month's storage. A typical container is a plastic bag with a few small holes for slow air and moisture exchange. Correct water content of the peat moss is indicated by a slight dampness which is impossible to regulate/gage initially. Chestnuts themselves, may have been too dry or too wet initially. At checking, the chestnuts are usually hard. If the chestnuts dimple, add a bit more peat moss which is 50% air dry and 50% squeezed dry. Check again to note dimpling/water need/root sprouting/need to plant.

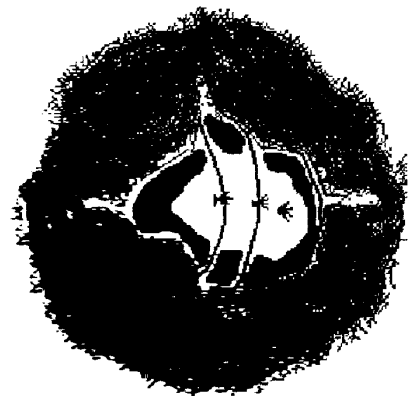
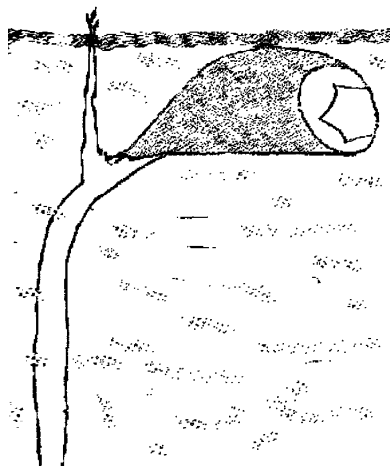
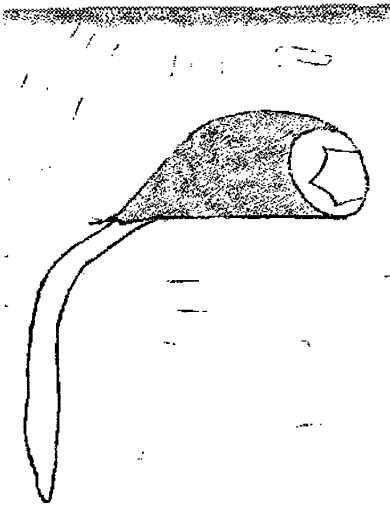
1. I do a little different, having well drained refrigerator chests on their backs set a foot/30 cm. into the ground. They are covered by their detached doors/reversed lids, and a carpet. The chestnuts have been stored in piles, stirred every few days (with a little dirt added each stirring on top) outside under carpets with cats often snoozing on them. At first snow, when mice often tunnel in the first snow-night, the chestnuts go into the refrigerator chests in 5 gal./20 l. plastic pails with small holes drilled at 2 inch/5 cm. centers. To space holes farther would allow condensation on the walls of the buckets, which grow white mold in the condensation. The lids are set lose on the buckets to keep out mice that initially escape mouse bait, and condensation from dripping into the buckets. The chestnuts freeze slowly, are punky, but send radicals, and are in a bit of soil. No mixing should be done before planting, or the few chestnuts that have gone moldy, spread mold to all. Chestnuts for use may be gathered from the very tops of the buckets to not spread mold.

D. Fall plant in fertile, well drained ground (some falls there is no well drained ground.) Fall planting allows some active organic matter in the soil, but not much. With the addition of moisture, chestnut seed will sprout, and push down root growth even at near freezing temperatures. Rapid root growth with rising ground temperature sinks the roots into more sterile soil. A well advanced root system will resist decay as activity begins in spring warmth.

E. To fall plant, lay each chestnut on its flat side. The point is to be horizontal. The root emerges from the point and pushes downward. After the soil warms, the stem emerges and pushes up. In fall cover the nuts with approximately 4 cm. earth, 2 cm. sawdust and 2 cm. earth. The second layer of earth and half the sawdust are only for insurance of the chestnuts being hidden, though deer tracks may spoil this. The top layer of sawdust disappears as the soil warms in spring, or it may cause moldy stems. Chestnuts should start to emerge in mid May.

F. To spring plant, repeat the above step, omitting the sawdust insulation/hiding layer. Soil preparation should have begun the previous summer with working and raking the soil to remove organic debris. Planting should begin as early in the spring as possible, with due regard for chestnut's ability to sprout, and grow under cold, damp ground conditions. Expect chestnut to root in April, in or out of the refrigerator.

G. When chestnuts start to appear, or rabbit digging and feeding appears, cover chestnuts with two layers of orange plastic diamond construction safety net. This netting should be



removed at leaf drop in fall.

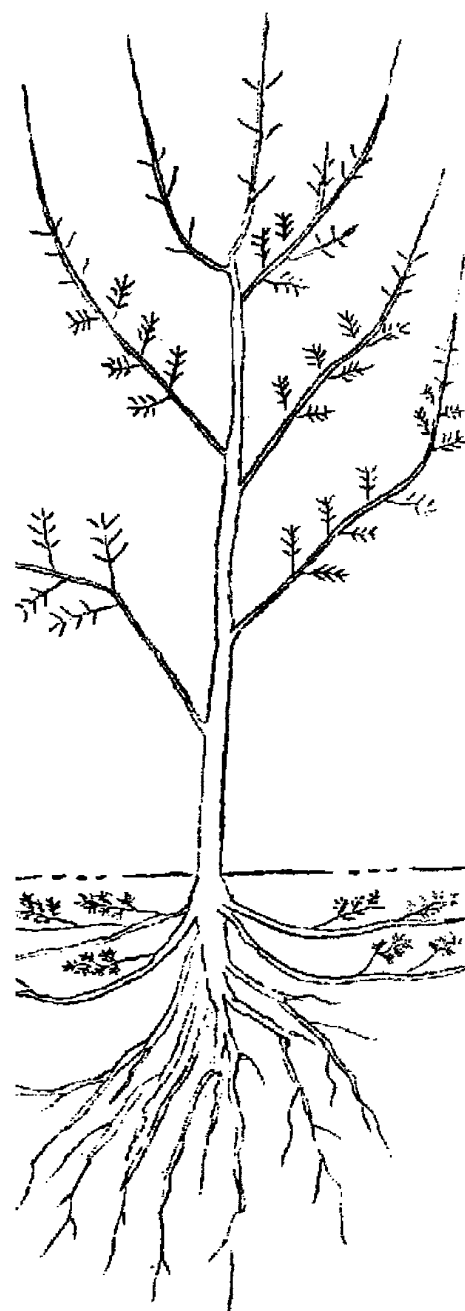
H. Just prior to chestnut seedling emergence, spray emerged grass and weeds with Roundup + simazine (or equal) to kill growing and germinating grass and weeds (temper this if simazine + Solicam mix was sprayed in the fall). If the planting is small, hand weeding, while weeds are small, is appropriate.

I. Protect the planting from animals. Where mice and squirrels are a problem, delay planting while removing habitat and baiting. In spring squirrels must be controlled long after chestnuts are up, or they will dig up kernels to nurse their young, thereby killing the trees. Ag-way and Co-op stores sell an effective orchard bait.

J. Planting sprouted nuts causes many mystery deaths. The root development of sprouted nuts is interrupted by planting during extension. This experience is lethal to apricots; only semi-lethal to chestnuts. Both these trees are noted for their root infections. Store chestnuts with just enough moisture (humidity) to keep them from drying. Given damp conditions chestnuts will sprout even at 32°F/ 0°C. If nut roots are longer than the planting furrow is deep, I clip off the excess root, being careful it is root, and not above the connection to the food sack above the root. A little root must be left. The root will branch out from the piece of root, and push downward. Sprouted nuts must be planted with the nut pointing horizontal, and the root going down. As temperatures rise, the stem will emerge at the point of the nut and push upward. Avoid root and mold problems by careful storage and early planting.

V. **Choosing a good site** for a chestnut planting is critical. Natural chestnut sites are slightly acid loam for orchard Chinese, to acid sand for a native chestnut, sand (fine yellow sand similar to tobacco land, or mixed sand and gravel). Sometimes yellow sand is a carbonate mix that needs a lot of sulfur mixed in. Drainage has to be excellent with the water table at least 5 ft./1.5 meters below the ground surface. Other native trees in the area are red oak, red pine, white pine, sassafras, native magnolia, and shagbark/bitternut hickory. Organic matter is in a dark, well decomposed, 8 in. /20 cm. layer at the ground surface. Much poor farm land fits this specification, although the organic layer has been exhausted by cultivation. This soil is difficult to improve because added nutrients quickly wash deep into the soil. Heavier soil could grow chestnuts, if well drained with ditches and drain tile. Although many chestnut growers find the reasons, and energy to transplant large trees, it is often more practical to find chestnut ground, and seed, and transplant small chestnuts into it. Fall planting the chestnut seed allows the grower to concentrate his efforts in spring on fertilization at spring break-up, and herbicide application just prior to seedling emergence. Fertilize the seed bed months ahead of planting to insure vigorous seedlings that will shade a hot, droughty, chestnut soil, then rely on directed roundup-simazine to suppress grass and weeds the first summer, then directed Roundup-Solicam applied at first fall frost to rid weeds for the next growing season.

A. Transplanting chestnut benefits from a year of preparation by fertilizing heavily in early spring, and remove grass and weeds by mowing, then re-fertilizing.



VI. Transplanting and maintaining chestnuts:

A. After grass has grown out 6 in./15 cm. in spring, kill sod in a 7 ft./2 m. spot with Roundup + simazine herbicide.

B. Dig the planting hole deeper and broader than the extended root system to be planted.

C. For a meter high transplant, mix approximately 2 lb./1 kg. bone meal into the planting soil. (Digging and mixing-in bone meal, and/or granular fertilizer during the previous summer is highly effective.)

D. Spread the root system, and trim off dead and badly injured roots. Roots greater than 1/2 in./1 cm. diameter, which have torn ends, should be pruned to smooth wedge ends. Do not let the roots dry off. Roots which look grown together, like straws on a broom, will resist spreading, but must be separated. Packing and stacking forms this unnatural congestion.

E. Place the root system in the hole so that the root crown is 2 in./4 cm. above the original ground surface.

F. Filter in the planting soil while spreading the root system. Remove weed roots and grass clumps from the planting soil as you come upon them. A fibrous root system on your transplant indicates a healthy, well nourished tree. The tree can be ruined by wadding together the roots. Rather than wadding, it would be better to trim off some of the hair roots. Inexperienced planters need supervising.

G. Poke a rod into the soil to move it between roots. Tug on the stem and tamp to consolidate the soil, while keeping the roots extended.

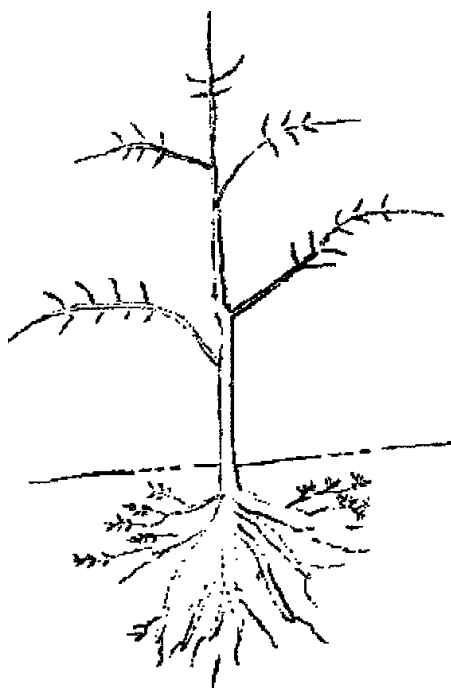
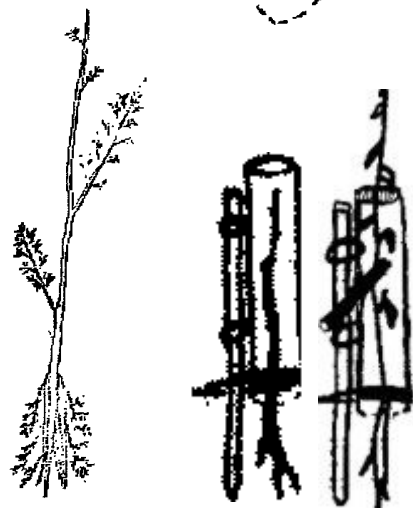
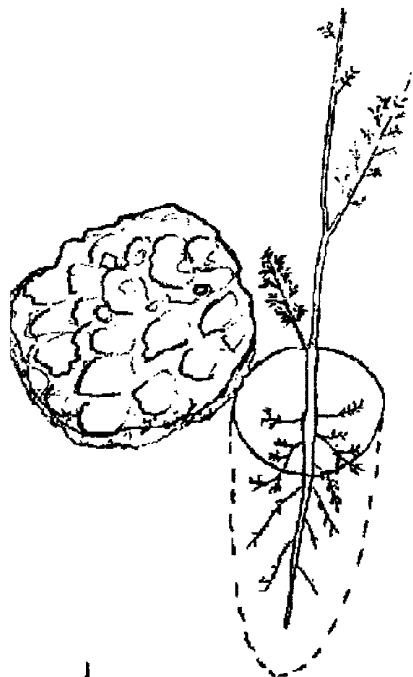
H. Water to help consolidate the soil, but don't flood out the filtering in of soil and tamping operation. I use water from a ditch, and add a dribble of agricultural sulfuric acid ,64 normal, to it.

I. After all the soil is replaced, mulch with soil to make a mound 6 in./15 cm. above the original ground surface. This mounding could be higher because in a year or two it will have settled nearly flush, and may need refilling above the root crown. Because insulating a cold spring soil is to be avoided, mulching with clear plastic is appropriate.

J. Stake a tree shelter over the tree, cutting it to fit 5 in./13 cm. above the tip of the tree, tapping it into the ground a few centimeters so that mice do not enter.

1. Alternatively, wrap the stem with a tube of octagonal plastic garden fence as tree guard against rabbits chewing, deer rubbing, and mower scuffing.

2. Irrigate with 5 gal./20 l. buckets of water to soak soil deep. Trim the top to remove dead branchlets and leaves.



K. Water as often as is necessary to keep the soil from drying out. Soak the ground to get the acidic water down to the tree roots.

L. Use granular garden fertilizer, scooping and casting it out from the tree to well past the drip pattern of the branch tips. Use 2 lb./1 kg. of 12-12-12 granular garden fertilizer for each inch/3 cm. of stem diameter May through August at two month intervals, or any time leaves go from dark to pale. Keep the fertilizer pellets 4 in./10 cm. from the trunk. Any pellets contacting the bark must be removed before they burn the bark.

M. When weeds return, hoe, or spray with Roundup + simazine.

N. In future years maintain a two meter wide bare or soil mulch around trees. If intercropping is not practiced, maintain grass strips between tree rows.

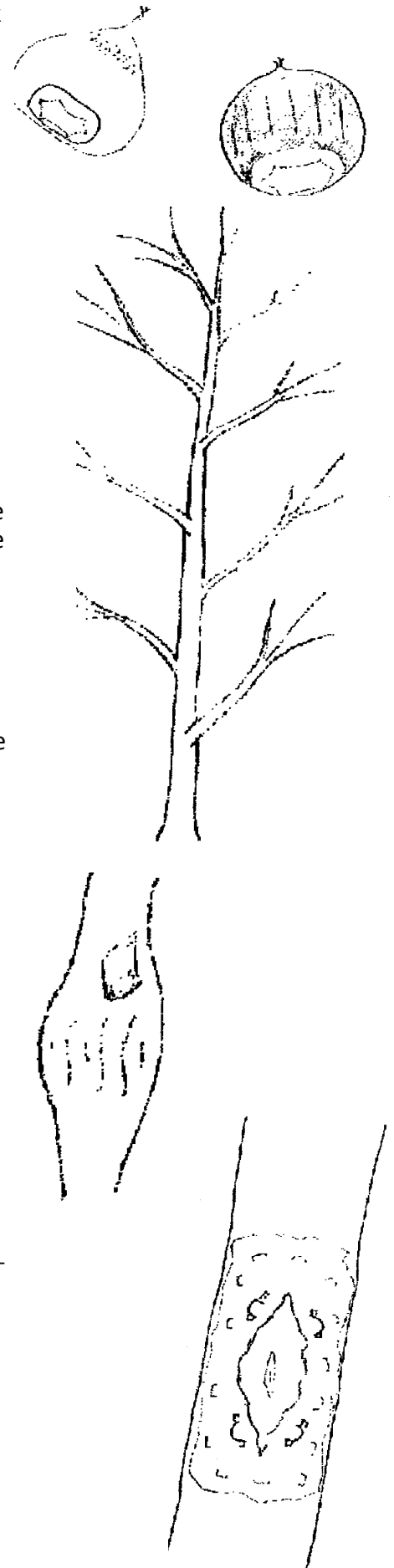
V. In future years prune only to remove dead, rubbing and malformed branches. Maintain a conical tree shape with the longest branches nearest the ground. Many sweet chestnut trees, even native, maintain the conical shape naturally, lowest branches following the ground, unless forced upward by tree crowding, or pruning when 1 in. /2.5 cm. diameter, as when in the path of the mower. A conical shape profile permits most of the terminal branchlets to fruit by eliminating the shading of branch ends, while protecting the trunk with dense shade, which works against sunscald, winter injury, and blight. Descending limbs gather more light, storing more energy, than those that tend upward. Increased bending, due to nut load, helps sugar storage in the drooping limbs. It will be difficult to keep low limbs productive on chestnuts. Their shade is too dense. Chestnuts try to shade out and discard low limbs. For nuts to size properly, the terminal wood has to be growing about 12 in./ 30 cm. per year above terminal burs.

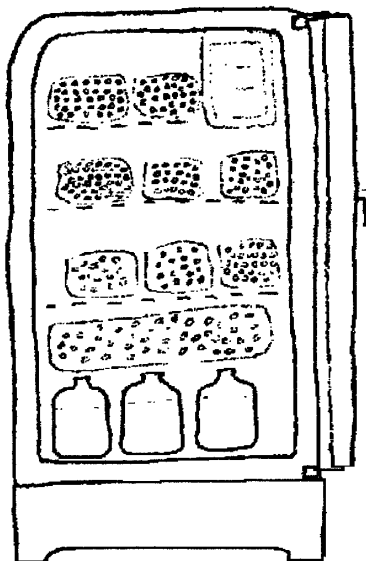
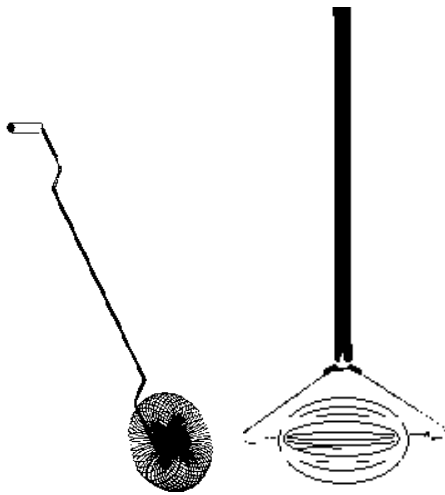
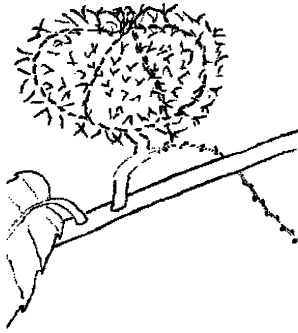
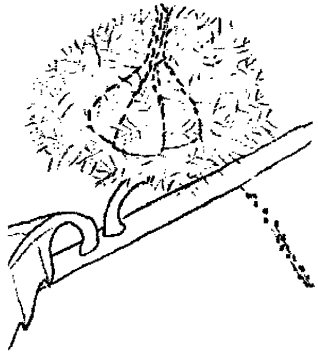
A. Once nut production is underway, after about 12 years, expect to be fertilizing at more than 1000 lb./500 kg. of 12-12-12 fertilizer per acre per year in split spreadings. A starter fertilizer **ammonium sulfate** is broadcast at spring break-up/(frozen ground under snow) to **increase chestnut flowering/terminal growth**, used heavily (400 lb. $\{NH_4\}_2SO_4$ per acre) a rate which would kill the tree if spread later in the year forcing to much/too late growth.) Go easy. The exact formulation is to be determined by experience, and the previous season's leaf analysis. Leaf analysis is tricky due to the ability of leaves to concentrate the minerals tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding. Mulching and keeping an active soil flora and fauna frees up bound minerals.

B. Begin removing trees before crowding. First, remove sick looking and stunted trees, and at 8 to 10 years start removing the poor producers. Maintain less than 50% noon shade on the orchard floor.

1. Herb Darling is a Buffalo native and president of the New York Chapter of the American Chestnut Foundation who pollinated large isolated natives to produce seedlings, thus saving the local trees for one more generation. Blight resistance is to be introduced to these timber trees through genetically engineered breeding partners which are currently being assembled by Professors Charles Maynard and William Powell at the College of Environmental Science and Forestry at Syracuse University. The first of these engineered chestnuts are in test plantings in the ground in NY, very much in thanks to Herb.

C. Trees, which can not wall off blight into 10 cm. by 15 cm. visible canker areas, should be scheduled for removal. (**Metric class 150 resistance** is the **width times height** calculated = 10 cm. x 15 cm. 5 cm. by 10 cm. are hoped for from engineered chestnut, which should heal over, and propagate resistance.





Good production of high quality nuts will warrant further observations. Also, blight itself may be attacked by virus-like parasites. It may prove beneficial to maintain cankers that appear to be weak forms of the blight. Natural inoculation of strong blight colonies by the weak forms is halting the lethal blight in France/Italy.

VI. Before harvest, cut grass, rake and remove debris which may hide nuts.

A. After the growing season remove leaves, dead branches, burs, and every day remove nuts from the orchard. Often these are homes for next season's pests. Chestnut weevils and filbert worms leave the nuts soon after they fall, and spend winter in the soil. Daily nut collection is sometimes necessary to "harvest" them, and rid them from the orchard.

B. Learn to identify chestnut weevil, and be prepared to spray filling and filled burs which are starting to open with a recommended insecticide (usually Sevin). The chestnut weevil finds the chestnut trees while they are blooming in late June, and lay eggs/weevil larvae in August/September.

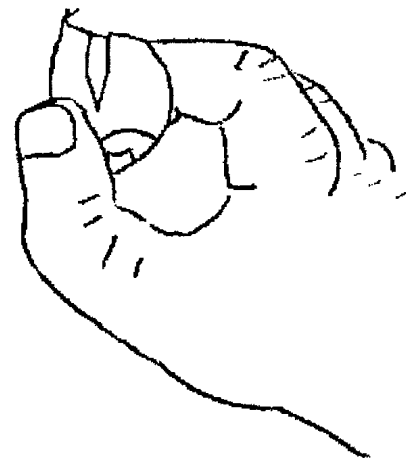
VII. Harvesting chestnuts is great fun for the young, and young at heart. Nuts lay bright on the ground, either loose, or held in the bur, ready for dumping by the wind. Shaking rains them down. The smart chestnut gatherer goes to harvest wearing thick leather gloves. The spines on chestnut burs can puncture skin, breaking off, and later festering. It is difficult to stay away from these burs when three bright nuts are spied in a partly open bur. Today's rolling coil harvesters make harvesting fun. Chestnuts in burs are picked up wearing leather gloves, and securing them from rodents until they open a bit.

A. Where squirrels are a problem, burs have to be gathered unopened. Long bamboo poles or aluminum tubes are used to swat loaded branches, flinging off the burs. Nuts that usually contain chestnut curculio larvae (chestnut weevils) should be harvested daily, and given a hot water treatment (into 122°F/50°C water for 30 minutes to kill the weevils/ eggs, then immediately cooled to 32°F/0°C to keep the chestnuts alive). Unopened burs usually have to be held for several days under cool, slowly drying conditions, before they release. The wet nuts must be surface dried and separated from green grass. Spreading nuts in a single layer on newspaper for a few hours drying in a dehumidified room, or other airy location, to dry nut hulls.

B. Chestnuts should be surface dried, and go quickly to refrigeration. Nuts for eating may be bagged, held fresh in a crisper for several weeks, but for planting, and long term storage, chestnuts have to stay near freezing through winter with no drying. 32°F/0°C high humidity storage is easily achieved by placing a non-operating refrigerator flat into ground, or in a cold cellar, and holding in plastic with pest moss and with several plastic 1 gal./4 l. jugs of water and ice. Put the surface dry chestnuts in plastic bags, or 5 gal. pails (drilled with numerous side/bottom vent holes). Check to see that the jugs contain water during a quick slide into cold weather to maintain slow freezing. Slow drying due to nuts transpiring at low air temperature will allow more and more freezing through winter. Ice chests set a foot into ground see good freezing until March, if in drilled plastic pails with covers laid on, and some mouse bait set. Every year nuts become spongy, freeze, but send root in early spring.

VIII. Usual **preparation of chestnuts** is to roast the nuts until they have cooked through. Before cooking, all but a few wilted nuts are

pricked with a knife to relieve steam pressure, easiest when punky. **Do not roast or microwave un-cut/un-pricked hard chestnuts** because these explode, and cause a mess. Cook cut chestnuts and test, then heat more if not done. Roasted nuts are sweet with a slightly grilled tang. Many people prefer raw punky (slightly dried) chestnuts which are sweet and mild. Raw chestnuts are prepared by air drying for several days until they feel spongy/punky. Keep checking them without drying them to hard, or rehydrating which would start mold under the hull. Besides producing a folding texture, drying increases sugar concentration. Drying can be continued until the chestnut kernels become rock hard. At this hard condition the nuts are almost unusable, but may be ground into flour, boiled until soft in water, or gnawed like a bone. They immediately mold if rehydrated. Punky/dehydrated/moldy chestnuts do not grow due to mold. However, stored in nature/held stratified in a partially in-ground chest, these slowly drying/naw punky/naw covered with frost chestnuts sprout root and grow when the return of spring brings heat, and moisture into the cold chest.



A. Small chestnuts are best slow boiled, like on a hot plate heating 20 minutes in a rolling boil, until they liquify in their un-cut/ un-pricked hulls. Cool, suck/squirt the fluid through the flower end.

B. Microwaved chestnut is an easily kibbled vegetable, like a potato. The flavor is mild, but not bland, being sweeter and nuttier. Much like potatoes, chestnuts should not be frozen raw because their cell structure is destroyed, and they rapidly decompose, but if boiled when partially unfrozen, they taste normal, especially if prepared by boiling before freezing.

1. To cook/semi-peeled chestnuts in a microwave:

a. Peeling the hulls and pellicles from chestnuts is the first step in many preparations. Cut raw, very large nuts in two at their thickest. Set the nuts cut side down, and cook for a minute. This removes hulls, and semi-cooks the nut. A minute of cooling, hulling, and a second minute of cooking brings up sugars, and removes more hulls.

b. Nip hulls with a knife where the edge of the scar rises out farthest, and rip it back toward the flower end without removing. You could make a "chestnut hull ripper" by tapering the lower jaw of a needle nose pliers away from the nut to pinch the hull at scar margin, and roll the hull it up over the top of the nut.

2. To peel a quantity of chestnuts:

a. Slit the nut just above the dull side of the chestnut (the scar side of the nut, opposite the point) across the nut along the scar, from side to side, with a sharp knife.

b. Spread nuts in a single layer on a plate and cook in a microwave for two minutes.

c. Remove and popped-off hulls and pellicles by squeezing the pointed ends after the nuts cool, but are still seem hot, or hulls glue on again. Rapid dehydration shrinks hulls and pellicles, and the uncooked nut is forced through the slit above the scar end of the nut. Kernels are still raw. They can be stir fried to produce a chewy sweet vegetable (not as crisp as a water chestnut), or go to freezer storage, then cooked while frozen in sauces, soups, but cook before use in turkey dressing.

3. Chestnuts which have air dried in the house for several days should become punky and pop hull directly, with no cooking. Roll the nut under finger or palm pressure to split, and remove hull and pellicle.

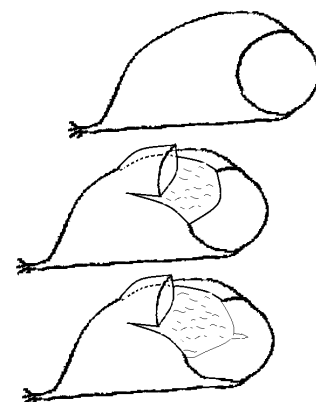
IX. Projects with chestnuts:

A. Experiment with fall planting of chestnut seed. Some native and hybrid varieties are so sweet with sugar that they lay on the ground all winter, and will grow.

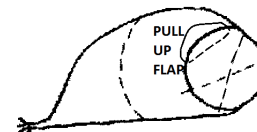
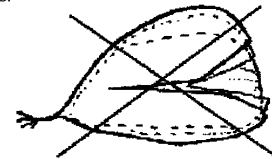
B. Experiment with seed planting at a permanent tree location.

C. Identify seed sources which produce hardy, resistant and compatible root stocks.

D. Breed hybrids for early ripening, large size,

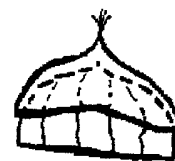


TWO OR THREE ONE MINUTE ZAPS WITH A HIGH HEAT MICROWAVE WILL COOK A CUP OF CHESTNUTS, AND DRY CHESTNUTS HULLS EACH WITH A FLAP OF HULL TORN BACK TO GREATLY EASE HULLING. PLATES TOP AND BOTTOM KEEP KERNEL FROM DRYING, AND OFFER SOME PROTECTION FROM EXPLODING WHOLE CHESTNUTS THAT WERE OVERLOOKED.



POSSIBLE CUTS FOR COOKING OR DRYING IN A HIGH HEAT MICROWAVE

LARGE CHESTNUT



resistance, high quality nuts, and hardiness. Northerners need Japanese hybrids for their early ripening, large, sweet nuts.

E. Locate Chinese without cankers in 10" to 14" dia. trees. Very hard to do because Chinese stop blight very slowly. Typical resistance class is over 200 cm², but holding.

F. Locate the best native form trees, best blight resistance, and best native forms of hypovirulence.

G. Relate leaf size, density of foliage, and winter foliage retention to blight resistance.

H. Try to resurrect the Paragon variety and native species of chestnut with hypovirulent blight.

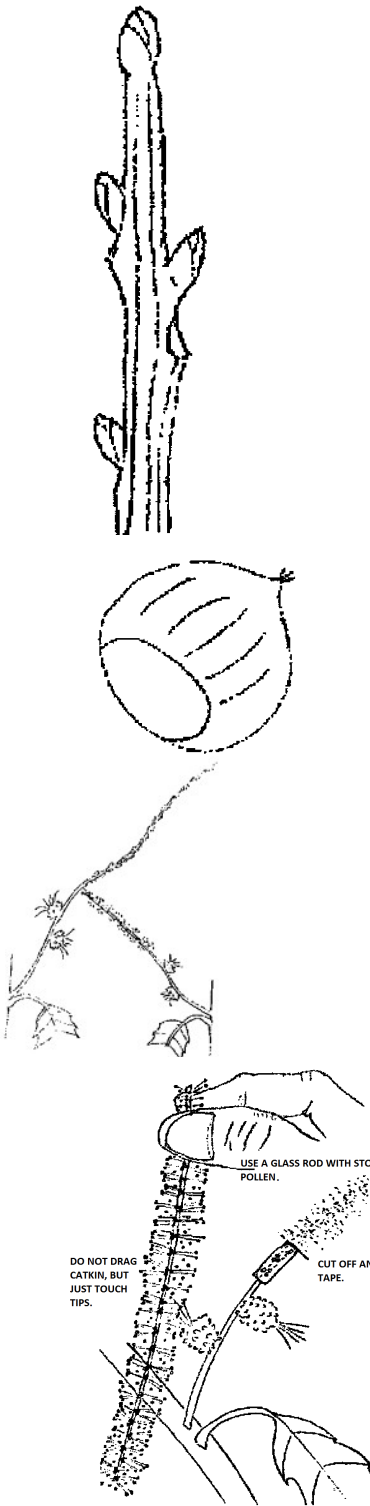
I. Plant early flushing chestnuts on north slopes to check on hardiness improvement.

J. Try mixed plantings of pine and chestnut.

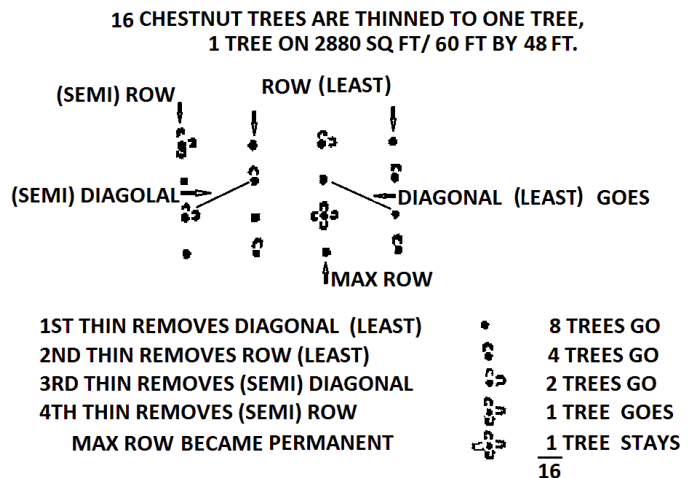
K. Breed for the European chestnut traits: adaptation to sweet, clayey soil; large nuts off young trees; rapid, stiff vegetative growth in young trees, followed by high production, and dwarfing in bearing trees, but with enough tip vigor and endurance to sustain large nuts..

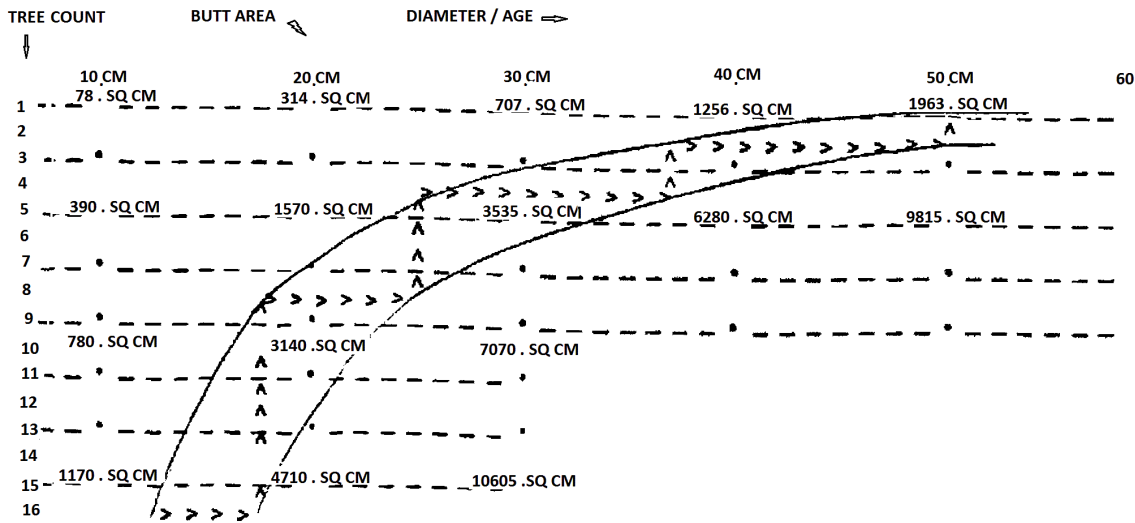
1. The fuel value, and timber value of chestnut wood is highly regarded, but fire wood snaps, crackles, pops with its oils under pressure, so is best burnt in a closed stove. The fuel value of chestnut is similar to red oak. Chestnut wood has very high strength to weight ratio. The wood is highly crack and rot resistant (the heart wood of chestnut), and it splits straight down the log. Thus, chestnut finds uses in turning, trim, furniture, paneling, telephoning poles, ties, rail fences. Today old telephone poles are being sawn into paneling. Chestnut can be split into long straight rails and fence posts. Costly reforestation of chestnut stands by planting is unnecessary due to chestnut root crowns sprouting after winter, and begin coppicing. The regrowth is faster and straighter than the original trees. Chestnut transplants sometimes lose their upright growth form. A common remedy is to cut them flush with the ground during winter, and allow the strongest of the regrowth sprouts to form single stem new trees. Native chestnut sites are often suited only to timber production. Native chestnuts were found in almost pure stands due to coppicing even on wind swept ridges where the soil is dry, rocky and acid.

X. The **thinning** block, drawn below, is constructed from six spacing factors (next page under thinning plot). Through the years the typical planting area, containing initially 16 trees, is cleared until one selected tree remains. The maximum diameter of a productive chestnut is expected to be 19 in./50 cm, 15 trees per acre. We space trees closer in north-south rows to help moderate west wind, speed application of pesticides, and ease machine movement and intercropping between rows. Current recommendation is to plant grafted chestnut trees 40 ft. on centers, and interspace with seedlings, or alternate with seedlings, and intercrop. Do not expect grafted chestnuts to be this long lived, or much able to sustain large nuts, but expect to move in good seedlings.



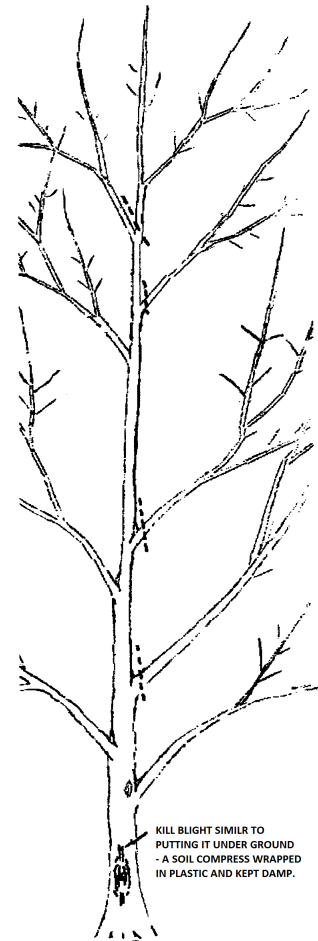
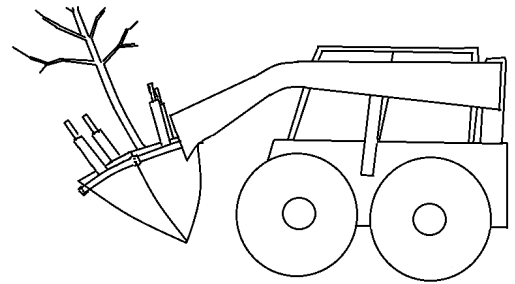
CHESTNUT / HEARTNUT / SHAGBARK HICKORY / OAK / GINKGO	BLOCK FT X FT	LAND AREA SQ FT	NUT TREE THIN DIAMETER,		TIMBER TREE THIN DIAMETER,	
			"START DENSITY" AT 30 SQ FT / Ac LIMIT CM	"START DENSITY" AT 30 SQ FT / Ac LIMIT INCH	"END DENSITY" AT 60 SQ FT / Ac LIMIT CM	"END DENSITY" AT 60 SQ FT / Ac LIMIT INCH
1ST THIN	15 X 12	180	12.2	4.8	17.0	6.7
2ND THIN	30 X 24	720	24.1	9.5	34.3	13.5
3RD THIN	45 X 36	1620	36.3	14.3	50.3	19.8
4TH THIN	60 X 48	2880	48.0	18.9	68.6	27.0





XI. **Thinning** chestnut trees is plotted above based on spacing observations for productive trees growing in fruit orchards under Lake's Region conditions.

- A. Approximately .0667% butt area for bearing = 30 SQ FT per Ac.=1/1500. This ratio for best bearing is the max fruit ratio used by fruit growers (50% shade/noon shadow.)
- B. Approximately .1377% butt area optimum fiber= 60 SQ FT/Ac.-fruit has declined and the fiber (log) production rate has just maxed, indicating the start of tree stress. This goes with less than 70% shade on the ground.
- C. Decline in both nut and fiber production shows real need to improve light in the grove, and indicates injury to the trees.
- D. Tree spacing has to change due to growth competition. This dovetails with the need to sort out selected seedlings. Odds are that in a group of ten selected seedlings, one will be exceptional enough to be made permanent. Baring disease, seedlings usually retain bearing of large nuts when very old.
- E. Tree spades are available to fall-move large trees without transplanting shock. These spades could be used to move selected trees, rather than chopping them down. More likely, grafted chestnuts would be planted at the more permanent locations though they are neither as long lived, or are they as able to continue growing large nuts.
- F. The production rates of chestnuts might be slower than fruit trees, but they are much longer lived, and harvestable when large.
- G. Drastic pruning can maintain chestnut production by allowing most light efficiency in the orchard while delaying the removal of trees. As chestnuts crowd and shade each other, energy conversion decreases, thereby reducing nut production. If drastic pruning is delayed until butt density reaches the point where fiber production decreases, nut production can be reduced by more than one quarter. More important, chestnut has to grow vigorously to six leaves past the bur cluster, or nuts are small, maybe un-sellable. Pruning radically the trees which are to be removed, thereby releasing more productive, and more permanent trees, maintains high production. Prune off entire limbs and sectors of trees that extend toward more worthwhile trees. Prune chestnuts during the dormant season to increase the vegetative growth necessary for large nuts. Try for 50% noon shade on the orchard floor, 70% shade on the forest floor.



thank you PROF. WAYNE WEIDLICK

XII. Propagation of chestnut selections is difficult because grafted chestnut trees are often difficult to maintain. Even with tender loving care, chestnut seems programmed to sprout from the root crown rather than maintain an injured top; such as a grafted top, which it mistakes for injury. Incompatibility often starves and throws off rapidly growing grafts. Despite these difficulties, the extra effort necessary to graft valuable chestnut selections is encouraged because it is necessary to establish breeding partners. Once a selection is producing seedlings, grafting it onto its own seedlings greatly reduces the incompatibility reaction.

A. Top working chestnut is most successful when grafting is done at the time of light frosts in early May. Later grafting will hardly ever grow as vigorously as is necessary with chestnut. The materials needed are:

1. Healthy rootstocks with a 1/2 in./1 cm. diameter stems (unless top working on larger trees) with terminals which are about to expand buds...close, genetically, to scions. Chinese is not close to other species. Cross breeding leaves a loop hung from a longer Chinese chromosome.

2. Pre-waxed 3/8 in./5 cm. diameter dormant scions...cut in March, cut to length, dipped in a paraffin/bee's wax/resin/tallow mix, wrapped in moist toweling, put in a sealed bread (or plastic bag) wrapper, refrigerated...best wrapping is layered, waxed scions in plastic bag, then wet paper toweling in second plastic bag, then a paper bag in refrigerator.

3. A razor sharp blade (able to slit a sheet of paper into strips)...the thin bladed knife (like Buck folding knife) capable of cutting curved chips off stems, rather than splitting them off...hone knife in against blade direction, last hone is against the side leaving a bevel which leads the blade turning in the direction you want the wood to curve; knife's curve is wood's curve, bevelled side is struck outside the curve into the wood.

4. Roll of 1/2 in. or 3/4 in. plumber's Teflon tape...to bind and seal unions.

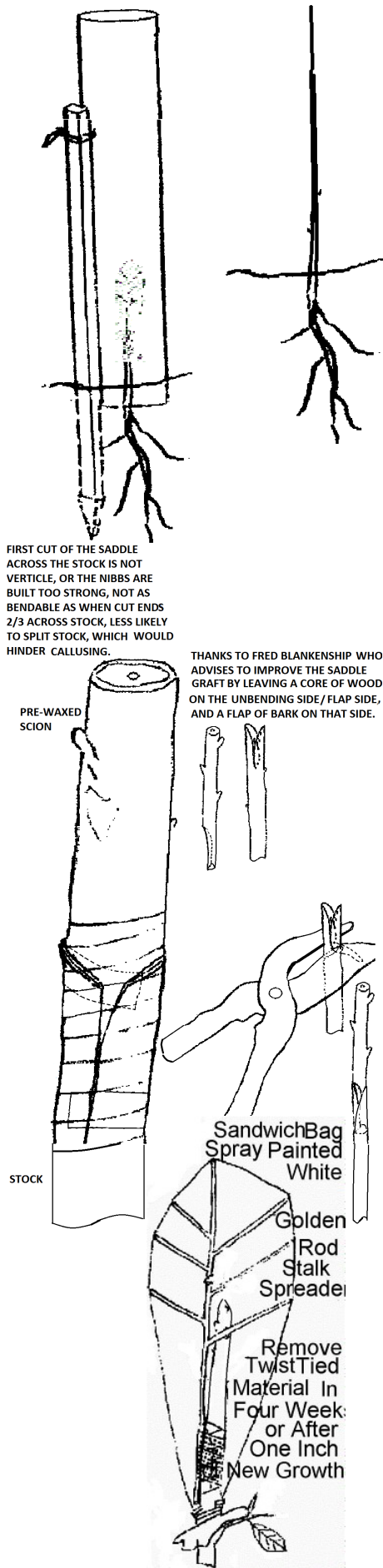
5. Branch-lets, weed stalks/ golden rod flower stalks, shaped like hat trees is masking taped to stock to extend the plastic bag off the scion.

6. Blenderm hospital tape, or electrician's tape...to clamp the last turn of Teflon. I get Blenderm from a medical supply, intending to do much grafting.

7. Plastic sandwich bags, or pint freezer bags...to "greenhouse" the set grafts for up to one month.

8. Masking tape...to clamp weed stalk and wrapper bag.

9. A can of white spray paint is used against sun side of sandwich bag like greenhouse paint. This paint blocks direct sunlight.



B. Method of **top working chestnut**: (See Grafting Chapter for the Pre-Waxed Dormant Scion/Plumber's Teflon/Aluminum Foil method.)

1. Gather 1/4 to 5/8 inch/.6 to 1.6 cm., or larger diameter dormant scions in March, or to just before bud movement. Store under cold, humid conditions. Crisper storage in a sealed plastic bag with a piece of damp paper towel, to exchange condensation, will hold scions six weeks.

2. Splice graft in mid to late May, using the **English graft** (heel & toe graft). Return the toe of the scion into the heel of the stock, and visa versa. This is to insure little dead bark. I use the inverted saddle graft, but I know it needs expertise in cutting, and in binding because it can explode apart due to rapid callus growth at the lower nibs, if the upper nibs are not clamped by a final loop of Blenderm.

a. Cambium to cambium healing is likely all along the union. A near perfect union is needed, or the graft easily gets infected and goes into decline. All growth within (below) 16 in./40 cm. of the union has to be channeled through the graft.

3. Seal the union securely with Teflon under tension bottom to top. Smooth and widen Teflon with a finger tip after a bit of stretching, or it will close to a string. The top curl of Teflon needs a turn of Blenderm. (If the grafting uses crimped aluminum protection the only after care is to rub out buds on the stock. Reasons against the aluminum method is crows and squirrels poke in to investigate what is in the foil, and the foil is cold early in spring, and no help in a frost, and no help with chestnut callusing.)

4. Masking tape the sandwich bag, and the hat-tree-shaped golden rod stalk to the stock, positioning its arms around the scion to give clearance between the scion and the about-to-be-placed sandwich/food storage bag.

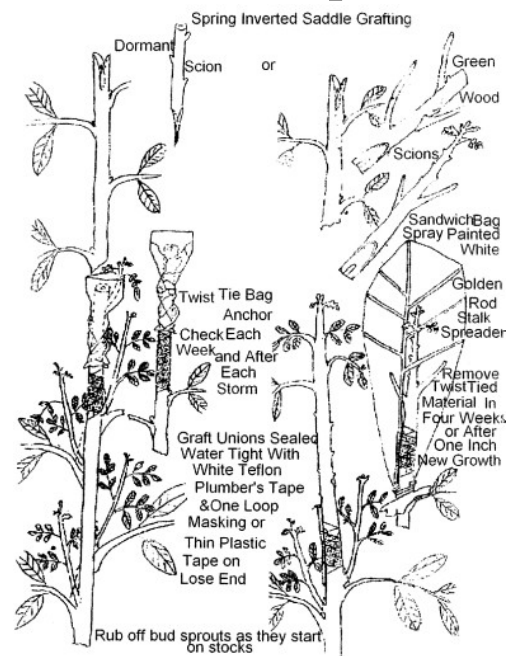
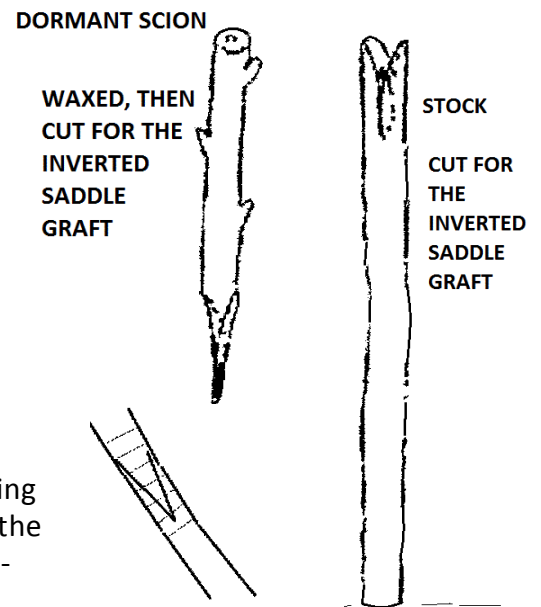
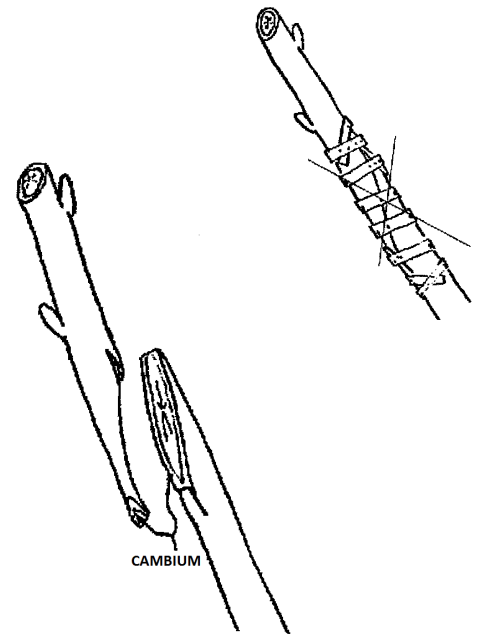
5. Cover the graft with the plastic bag, drawing it down until resting on the hat-tree-shaped stalk. Seal the open end of the bag against the stock with the masking tape. This vapor barrier should now be completely air tight, and the water that collects is far below the Teflon/union.

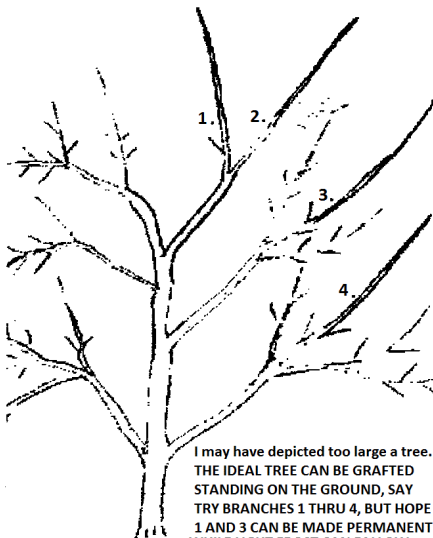
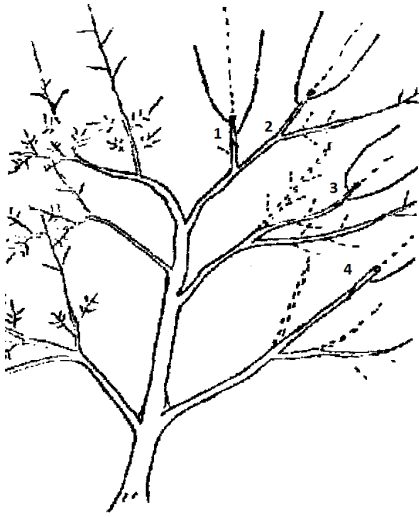
6. Spray paint the bag wherever direct sun can strike during the heat of the day. The white paint is a sun screen which prevents overheating of the graft chamber.

7. Check the graft at two week intervals to rub out buds which appear on the stock, and after each rain to dump any top heavy water.

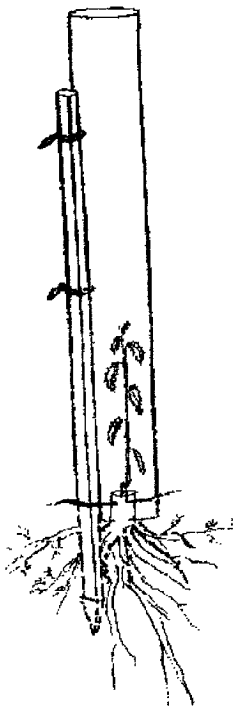
8. Four weeks after placing the graft, remove all material and bindings except for the Teflon and Blenderm at the graft union which will expand through the years to mark the graft union.

a. Incompatibility runs high in chestnut grafting. If initially grafts start growth rapidly, but you later see it dead, suspect incompatibility, even if you do not see the sure sign, the big bulge at the graft union. If a big bulge, that incompatibility will cause a break-off of scion in coming years, even after some bearing. This stock should hold scions more closely related to the stock.





I may have depicted too large a tree. THE IDEAL TREE CAN BE GRAFTED STANDING ON THE GROUND, SAY TRY BRANCHES 1 THRU 4, BUT HOPE 1 AND 3 CAN BE MADE PERMANENT. WHILE LIGHT FROST CAN FALLOW,WORK HIGH USING THE PLASTIC BAG FROST PROTECTION.



b. Oriental chestnuts, which are top worked to native, often suffer winter injury on their trunks. They need shade from leaves retained through the winter. Several oriental limbs should be retained low on the south and west sides of these trees. In fact, you should view all chestnut as needing to retain/hang leaves low on their branches as does American chestnut. The tip leaves of that growing season should drop. Branches which retain all their leaves are stripped after a heavy, wet snow. Some retain no leaves and suffer south-west injury. I have an fastigiated English white oak that retains most of its leaves all winter, but when a three foot heavy, wet snow of October 12, 1996 caught the green leaves on everything, and many trees were ruined. The fastigiate European white oaks lost many limbs, but due to all minor limbs, they quickly renewed.

c. The use of tree growth tube shelters (tree shelters) is especially suited to the very hardy American chestnuts, and filberts, year round. They aid the recovery of transplants, and are set over chestnuts in our Save -The-American-Chestnut-Program to flag trees during summer mowing of tall grass and weeds. These native trees grow late into the fall, but harden-up for winter very quickly. They will also give good grafting conditions to engineered selections grafted near the ground on stump sprouts, graft unions mounded with earth as blight protection. This should allow rooting of engineered chestnut from above the graft union. American chestnut will self root, but only off a shoot or blind bud which starts form under the surface of the ground.

d. Tree shelters improve transplant survival so that weak grafts may be started, and be bent to growing vertical.

XIII. Selected chestnut seedlings are the most desirable trees for transplanting. They possess fast upright growth, dark green foliage, large leaves, large diameter branch-lets, winter hardiness, and some fall leaf drop near the time for heavy frosts. Leaves held through the winter are no defect, if they are the sun screen leaves on the lower third of the past season's growth. Their parents should be known for large sweet nuts, heavy bearing, good tree form, and good blight resistance.

A. Chestnuts which are being grown in Ontario can be divided into Chinese and hybrid groups:

1. The Nanking Chinese are productive in Niagara, and along the shore of the Lake. Away from the Lake they suffer from winter injury in their tender terminals. In Iowa Orrin Chinese does better because that climate is more a hot Chinese climate than is NY's. Southwest bark injury is common due to a thin bark which is easily heated by the sun then freezes at night. They lose crops from freeze injury due to October ripening. They lack the vigor of native chestnuts. They are small size, inch nuts.

2. The Gellatly selections are grown in Niagara, at Brantford, and by the Lakes. They resemble hybrids of oriental chestnut pollinated by native and European, although J.U. Gellatly said they

came as seed from China (but look more look like the complex hybrids.) Some Gellatlys are more vigorous and hardy than the Nanking Chinese. The Layeroka variety was tested at the Vineland station, and found to be semi-commercial/semi-hardy by the Lake.

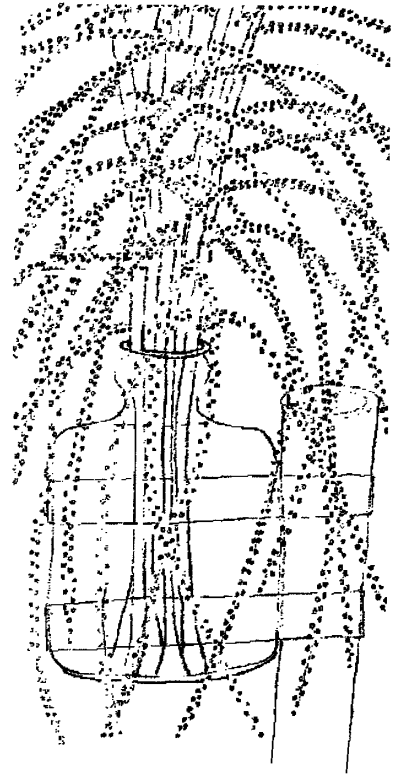
a. Simpson chestnuts are even more European than Gellatly. They retain the European ability to grow on a sweet garden soil and produce large nuts in their first crops. Unfortunately, European's ripening season in October is also retained, thus they recover poorly after heavy cropping, bringing down nut size and hardness.

3. The most hardy group of chestnuts are the natives. They are at home in Niagara, Hamilton, Oakville, Montreal, London and Sault Ste. Marie. They lack blight resistance, and it is by luck that they are still with us. They are timber trees. Nut size and production are lacking. Used to pollinate oriental, they show potential, but are too weak in chestnut blight resistance, so far.

4. Douglass 3/4 American hybrids are now being grown in Niagara, but have not been tested farther north. Selections among them have class 200 cm² resistance, native form, quality nuts, some productivity, hardness below -20F/-30C, below 6.5 pH soil tolerance, and September ripening. Earl Douglass originated these NY X PA hybrids in Red Creek, N.Y. by pollinating what he called Manchurian chestnuts with natives. Douglass hybrid chestnuts need acid soil, but not blueberry acid soil.

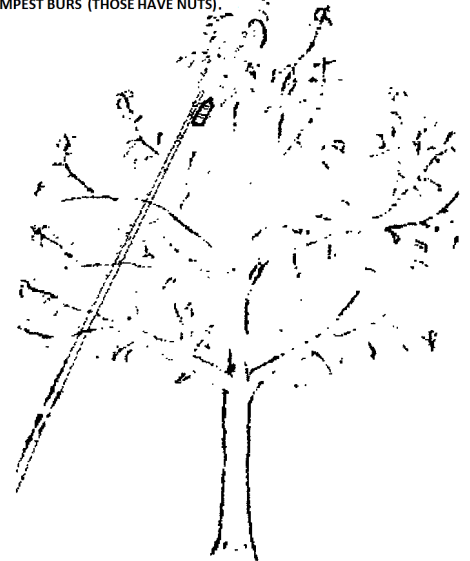
5. Japanese complex hybrids, and European complex hybrids, have good nuts, but incomplete resistance. The Japanese sorts are earlier ripening, but more subject to south-west injury. The European sorts are late ripening, but more south-west injury resistant. Most hybrids seem to prevent blight until they start bearing large crops.

XIV. We can gather, and select hypo-virulent blight infection. Hypo-virulent blight can be found in many chestnut sites as white blight pustules growing slowly, usually not near the red-orange pustules of virulent blight infected trees. On selected hybrid chestnuts the three-way contest of hybrid chestnut versus virulent blight versus hypo-virulent blight fight is a long interesting contest. Hypo-virulence becomes a tool for protecting productive trees with almost enough resistance (class 150 resistance that stalls virulent cankers at 10 cm. wide by 15 cm. high). We spread infection among the class 150 resistant trees until healing forms of blight are bread, and spread naturally. Inoculation can introduce light colored hypo-virulent into the red if cut white bark is joined into dying red bark in April, cutting-in flap pits, and white plugs, across the battle boundary (the canker margin turns from healthy greenish bark to brown bark where the red blight is trying to extend). Bark plugs with young white pustules are inserted under flaps of healthy bark cut around the red canker. Staple clear plastic film over the whole region with a paper stapler. When we see blight postulating white under this plastic we are seeing the canker walled-off, and blight forms breeding for natural spread. Today, chestnut blight resistance of the 150 class is no triumph because a hot, dry, fruitful summer takes away this resistance. The 2010 Zoar test planting has had its first blight kill of a transgenic chestnut in its first summer. The canker was tiny, looking caused by pruning a sprout from the root crown of a small replicant with a blight infected tool. If it turns out this is a resistance class 30 tree (canker stall at 10 cm. vertical by 3 cm. horizontal) it will show this clone is actually a great transgenic. A class 30 tree is no defect if it can stop cankers at 30 cm². 30 sq. cm. in a large tree is a hard-to-notice welt, like in the best Chinese.



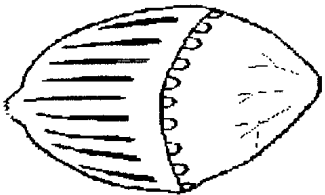
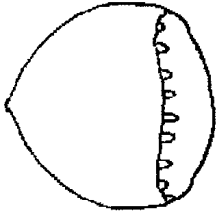
PLASTIC BOTTLE WITH QUARTS OF FLORAL STAY-FRESH SOLUTION.
INSERT BRANCHLET ENDS, "CRUSHED", FROM DESIRED POLLEN TREE.
POLE LONG ENOUGH TO PROP HIGH UP IN ISOLATED NATIVE CHESTNUT.

ISOLATED AMERICAN/NATIVE CHESTNUT OFFER THE OPERTUNITY TO SET
OUT BOTTLES OF BLOOMING BRANCHLETS (ENDS CRUSHED) IN FLORAL STAY-
FRESH, QUARTS LIQUID ...ABOUT JULY 1ST WHEN BLOOM IS CREAM COLOR,
INSECTS THICK...RETURN BEFORE OCTOBER 1ST TO CUT DOWN THE
PLUMPEST BURS (THOSE HAVE NUTS).



FILBERTS

(Hazels, Hazelberts, Filhazels, Tree Hazels, Trazels)



I. Filberts are Ontario's most widely enjoyed nut. The largest nuts are European filberts, *Corylus avallana*, or crosses of European with native american hazel, x *C. americana*, or native beaked hazel, x *C. cornuta*. The American and beaked American are half lilac size bushes when they start cropping. Some tree hazel hybrids, x *C. colurna*, grow like a pear tree. Selections of hybrid tree hazel which produce large nut are often called tree filberts, trazels.

A. Native hazels are gathered for home use throughout Ontario.

Open husk hazels are native through Algonquin Park and Manitoulin Island. Beaked hazels with irritating hairy hulls are native from Eastern Quebec through James Bay.

B. Filberts as large as the imported varieties are bearing in Montreal, Toronto, London, and Morden Research Station in Manitoba.

C. Filbert nut flavor is appealing to most palates.

D. Cracking and kernel removal is simple even with hybrids due to a shell that is round, without convolutions, some almost egg shell thin.

E. Most filberts and filbert hybrid **selections** drop free of their husks, partially dried.

F. Planting select seed produces about one seedling in ten that equals the selected parents.

II. Limiting factors in filbert production:

A. Hardy native hazels, tree hazels and some filberts are small nuts enclosed by husks, unable to drop free. Husk enclosed nuts drop over a long period, usually with leaf drop, and holding blank nuts.

B. The most productive stands of native hazels are reported in Eastern Quebec, but they go un-harvested due to the difficulties of gathering and husking.

C. Hazel gathering, husking, and cracking inventions are few. Hand labor is too slow.

D. Filbert selections bear heavily only where sheltered from desiccating winter winds, and timed to bloom in cool moist breezes of mid-spring.

E. Kernels are often hard and chewy, and only a few varieties are melting-kernel like almond.

F. Filbert blight and Eastern Filbert Blight are only recently coming under control with concentrated research and breeding at Corvallis, Oregon, at Guelph University, Ont., and at Rutgers in New Jersey.

G. Filberts are easily water stressed because of non-waxy leaves that hang on in drought, and shallow root systems. Their leaves brown, and upper twigs, and even stems, die back. Filberts are a products of wet glacial periods, side of bank, pH 6.3 growing in their recent past.

H. Blue jays, squirrels, and raccoons are the major crop destroyers, followed by a long list of others not so adept. Long entangling husks are a temporary asset until nuts ripen.

I. Local propagation is by seed due to too few great selections. Excellent seedlings have developed, but layering them is not a big local occupation

J. Simazine, which is usually the economical herbicide for release of nut trees, is tough on young filberts due to their shallow surface roots. Though filberts are sensitive, simazine is used on them, if they are in dark organic soil, or several years old/near bearing size.

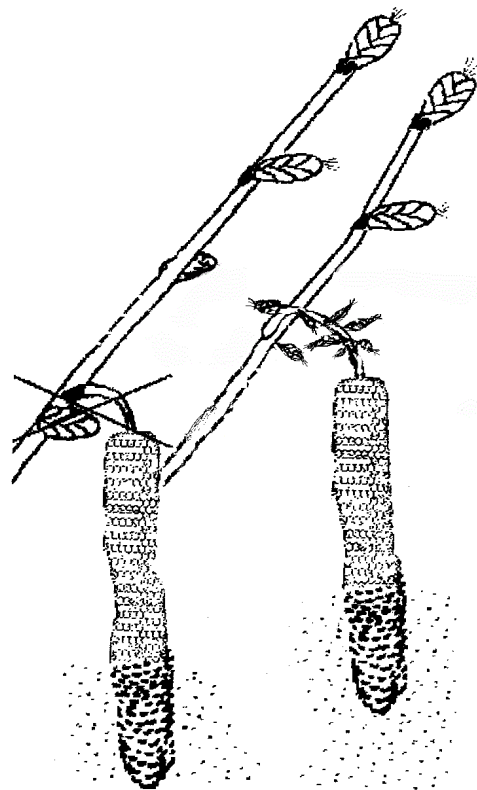
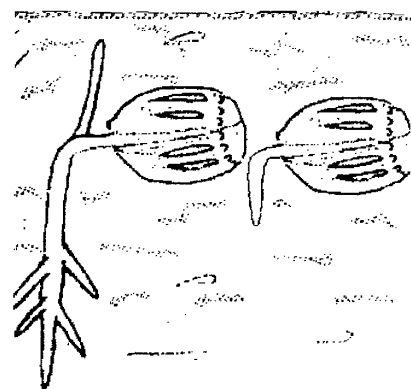
K. Shrunken kernels are often found under attractive shells, and good production, but these bushes must be discarded, maybe moved south or irrigated, if the misshapen kernels were not insect/stinkbug caused.

III. **Germinating filberts** or hazels is difficult because the nuts take up water slowly. Nuts, which are dried for eating, require eight weeks of cold, moist stratification in moist sand to germinate at a fair rate. Bringing the stratification container into the early spring sun and climate helps, if kept watered, and frozen and thawed in a spring cycle above ground. Mark your planting well because germination, especially of tree hazels, may take two years.

A. **Seeding filberts or hazels:**

1. Harvest nuts before they dry.
2. Refrigerate the nuts in a crisper until the ground cools in the fall.
3. Fall plant the nuts, or stratify them in a wire package.
4. To fall plant, cover the nuts with 1 inch/3 cm. earth and 2 cm. sawdust. Add on a little earth to hold the sawdust in place.
5. To spring plant, at spring break-up, cover nuts with 3 cm. earth and 2 cm. sawdust.
6. Keep the sawdust from drying out until most nuts are up.
7. Lay two layers of orange diamond mesh plastic construction safety fence over the planted seed.
8. Scatter or place mouse bait.
9. Just prior to the emergence of the seedlings, spray Roundup plus a small amount of simazine that will only slow weeds.
10. Remove weeds by hand weeding, and directed herbicide sprays.
11. At first fall frost, spray light strength simazine + normal strength Solicam herbicide.

IV. Choosing the site for a filbert planting is the most important step in a grower's plan. The soil must allow 4 ft./1.2 m. deep roots. The soil is to be between 6.2 and 6.5 pH, and rich enough to grow a thick plant cover. It should be modified with granular fertilized, calcium, and enough sulfur to stay acid. Filberts will not crop well on wet sites, or sites where drying can enter 3 ft./1 m. They really like the shoulder part of a hill where the water keeps descending. The ground must be well drained with ditches, or drain tile. Filberts need cross pollination. On most sites this is seldom a problem because of the practice of planting filberts in seedling, pollinator groups. Catkin killing due to sustained -15°F/-25°C wind (or short bloom receptivity due to harsh spring wind) eliminates filbert production due to killing of the extending pollen, or extending females. Choose a site protected from the wind. Likely sites would be in the lee of a woods, pine stand, hill, or other vegetated, and built up areas, yet open to the sun.



V. Transplanting and maintaining filberts and hazels:

A. After grass has grown out 4 in./10 cm. in spring, kill sod with a 7 ft./2 m. spot of Roundup, or equal. Let the Roundup spray dry (absorb) before digging, about 3 hr.

B. Dig the hole deeper and broader than the extended root system to be planted.

C. For a 3 foot/meter high transplant, mix approximately 2 lb./1 kg. of bone meal into the re-plant soil. (Digging and mixing the previous summer is highly effective, and at that time you could mix in 2 lb./1 kg. 12-12-12 granular fertilizer because it will be absorbed, and not injure roots in a few months.)

D. Spread the root system and trim off dead and badly injured roots. Roots larger than 3/8 in./5 cm. diameter which have torn ends should be pruned to smooth wedge ends. Do not let roots dry off or sunburn. Roots which look grown together, like straws on a broom, will resist spreading, but must be forced apart. Packing and stacking forms this unnatural congestion.

E. Place the root system in the hole so that the root crown is 2 in./5 cm. above the original ground surface.

F. Filter in the planting soil while spreading the root system. Remove weed roots and grass clumps from the planting soil as you come upon them. A fibrous root system on your transplant indicates a healthy, well nourished tree. The tree can be ruined by wadding together the roots. Rather than wadding, it would be better to trim off some of the hair roots. Inexperienced planters often need supervising.

G. Tug on the stem and tamp to consolidate the soil, while keeping the roots extended. Use a stick or shovel handle to rod soil between the roots.

H. Water to help consolidate the soil, but don't flood out the filtering in of soil and tamping operation.

I. Build a hill 6 in./15 cm. above the root crown with brought in soil, which will quickly disappear with settling.

J. Mulch with clear plastic film, if you have it.

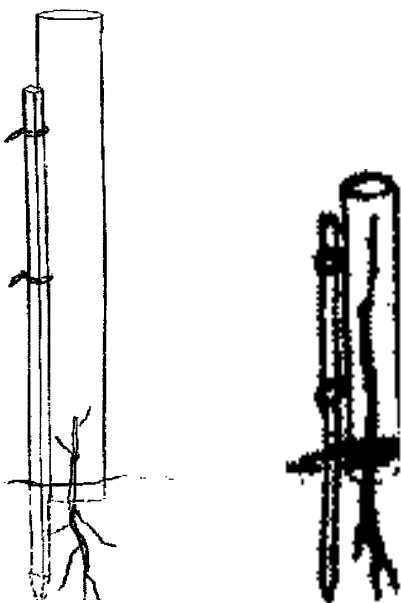
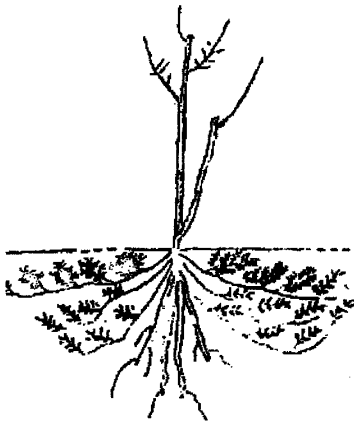
K. Cut stems of the bush back to 1 so it looks like a tree, and try to maintain it as a tree by using a tree shelter as a collar that you can fill with a loose chips and leaves, which discourage root crown sprouting.

L. Stake a tall tree tube shelter over the tree, tapping it 2 in./5 cm. into the ground so that mice do not enter. Filbert is hardy for years in a tree shelter. Trim off ant competing sprouts, and add more leaves over them.

M. Water deeply and as often as necessary to keep the soil moist with 5 gal./20 l. pails of water. Soak the ground at each watering to get the water down to the tree roots.

N. Use granular garden fertilizer during growing seasons, starting at transplanting and at two month intervals, 2 lb./1 kg. per inch/ 2 cm. stem diameter, casting away from the trunk and well past the limb spread. Expect to burn wet weeds and wet grass with 12-12-12 like a weak chemical hoe. This is why you have to remove pellets contacting the transplant.

O. When weeds return, mow, hoe, or spray Roundup-and a bit of simazine. The last spray of weed killer for the growing season should be simazine + Solicam at first fall frost. The Solicam part works during cool and cold weather.



P. In future years maintain a 7 ft./2 m. wide bare soil mulch around the trees. Use Roundup + simazine to kill grass and weeds after catkins are observed on the filberts. Maintain grass strips between tree rows, unless other intercropping is temporarily employed.

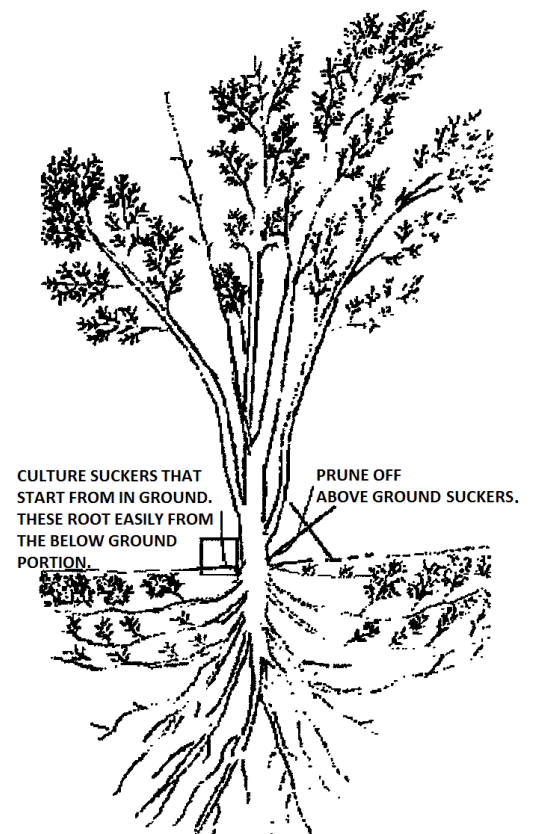
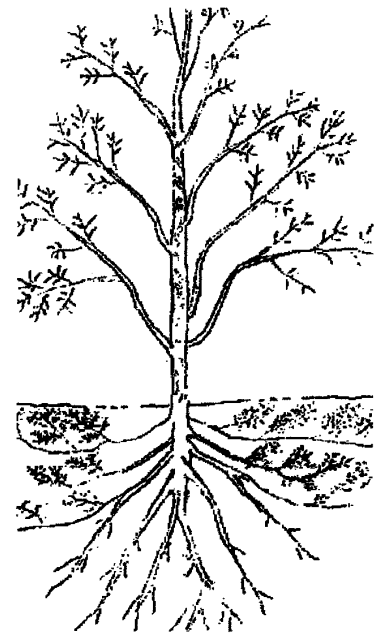
Q. Single stem tree hazels, and their hybrid forms called tree filberts or trazels, should be trained to conical shapes. It is only easy to shake down filberts by hand until the trunk is 4 in./10 cm. in diameter. After that you need a mechanical shaker. Usual pruning is only to remove dead, rubbing and malformed branches. The conical shape is drawn in at the top with the longest branches hanging near the ground. This aids photosynthesis and fruiting by exposing all branches to direct sunlight. Drooping branches store more sugar than upward tending branches. Filbert bush stems are fan shape so removing outer stems lays open the center of tree/bush to light.

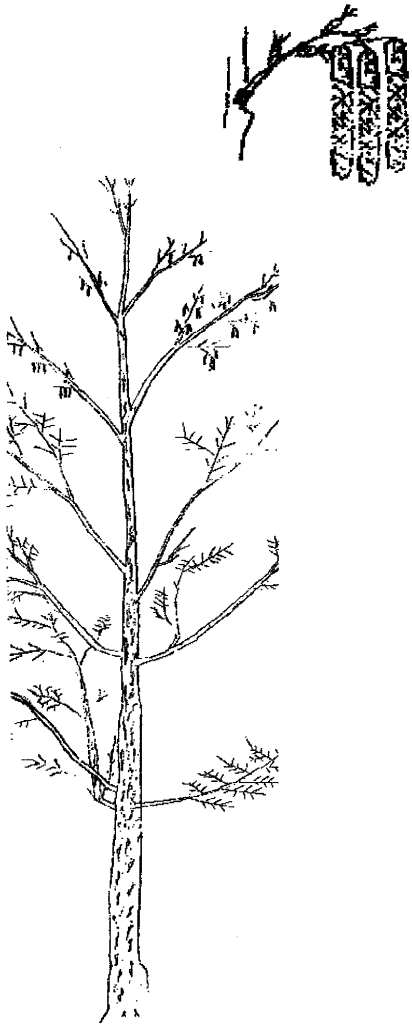
R. Native hazels and some filberts divide into many stemmed bushes, often suckering so freely that they can only be grown as thick clumps. Unless the clump is an unusual producer, it is often removed. Clump hazels may be an advantage in native stands by providing their own wind break, but they are a nuisance in orchard management. You will notice that when a stem gets 3 in./8 cm. diameter it is hard to shake by hand to get filberts down. A mechanical tree shaker needs a single stem to grab easily.

S. Filberts and hazelbert hybrids naturally grow into 15 to 20 foot/4 to 6 meter tall bushes of from 6 to 10 stems (1 stem is ideal using collar shelters and Gramoxone contact herbicide/Treevix.) Usable trees divide into multiple stems just above a noticeable root crown, which can choke each other. Multi-stemmed filbert bushes generate more and more stems from the root crown as older stems pinch off, and decline. When a declining stem is noticed, a dead branch or other injury can usually be found which has introduced decay into the core of the stem. Remove the declining stem flush with the root crown. Mound the root crown with earth to simulate filbert's natural defenses. Filbert looks to be very healthy underground, and even nourishes truffles. Depending how a small tree is fruiting, training to save some low branches will maximize crop because they bend into full sun at the perimeter of the bush, and are the heavy producers.

T. A few filberts resist dividing into multiple stems at the root crown and form a single short leader. The leader soon divides into upward tending stems. Unless stems are in full sun they are not productive. Save branches with strong attachment above 4 ft.

U. Once nut production is underway, after about 8 years, expect to apply 1000 lb./500 kg. of 12-12-12 fertilizer per acre in split spreadings beginning early spring. Exact formulation is to be determined by leaf analysis. Leaf analysis is tricky due to the ability of leaves to concentrate the minerals tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding. Mulching to keep an active soil flora and fauna, frees up bound minerals, but these have to be renewed.





V. After 6 years growing, cull out poor producers. Filberts (not so much tree filberts) which refuse to bear while young, seldom become good producers. Full tree hazels and back crosses to tree hazel can take 10 to 15 years to start bearing, so try for definite hybrids.

W. Before harvest, cut grass, rake and remove debris which can hide nuts.

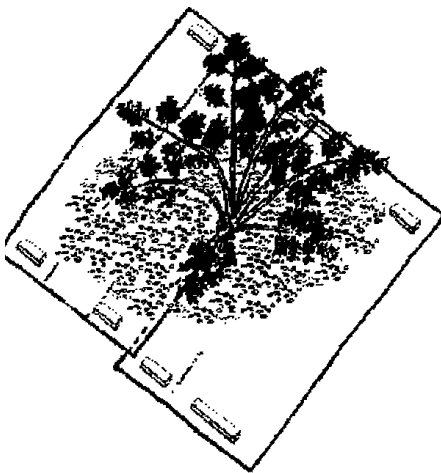
X. Early fall pasturing can remove leaves, dead branches, husks and nuts which are homes for next season's pests. Bushes must be large, and forage available, or bushes are rubbed, but rarely browsed.

Y. Learn to identify Eastern Filbert Blight, EFB. (Rapid decline of a stem, proceeding down from small, dead top branchlets, which look winter killed, and running vertical in a straight, sunken line of pin head black dots and dashes, spore pustules of EFB.) Remove infected stems in resistant bushes good enough for breeding, and eradicate all the highly susceptible bushes. Spray resistant bushes in March/April as growth starts with Bordeaux mixture. Fertilize heavily. The University of Oregon, Corvallis stepped up research on EFB, *Anisogramma anomala*, when it invaded West Coast filbert orchards in the 1980's.

Z. Grow filberts and autumn olive (*Elaeagnus umbellata*) within touching of each other. This is what happened In 2001, here. I had thousands of EFB infected filberts and autumn olive leaning on each other. It looks like EFB passed to Autumn Olive (same blotches appeared on A.O.), and when it passed back and forth, it carried a virus (or something) that has knocked EFB off all filberts and A.O. You probably can guess why this completes my Filbert/Hazel breeding with the saving the 300 large bushes which never had EFB: No EFB. No test. I will try Ennis again, an old favorite. What sort of resistance did we get? Maybe the same resistance that lets Europe and Asia go free of EFB. Anyway, no more breeding here against EFB in filbert or autumn olive for the foreseeable future.

AA. Dr. Tom Molnar at Rutgers in NJ is evaluating EFB resistant filbert selections, and cropping. He puts out good new information.

VI. Harvesting and storing filberts can be fun. Filberts are held loose in the husk in late September. Shaking a stem can rain nuts down onto a drop cloth. When first harvested, nuts are moist with a slight peppery taste. The nuts may be dried by placing them in a thin layer on several sheets of newspaper in a dehumidified room. In 4 or 5 days they are eating quality. Similar methods of drying involve blowers, and drying trays in airy conditions. Once dried, the nuts may be stored in ventilated metal containers in a cooler. A porch or shed will do for storage, if the container is mouse proof. Nuts will stay fresh all winter, but in a heated room their shelf life is less than a month. They become rancid. Once nuts taste slightly rancid, they will no longer germinate. Nuts for planting should **not** be dried, but be kept cool/cold/airy until stratified/mixed with moist sand/peat moss in a cold, mouse proof, in-ground container.



They can temporarily be held in a crisper for fall planting, or packed in sand within a wire pouch for stratification, then go to spring planting. Filberts cannot be left in the refrigerator for soaking and spring planting because their nut shell has no suture, and no way to quickly rehydrate, except cracking, and a gibberellic acid (seed treat/grape spray) treatment. Many dried filbert seeds in soil remain viable and germinate the second season after planting. If the summer is 90°F/ 32°C hot the seed goes rancid, and will not germinate.

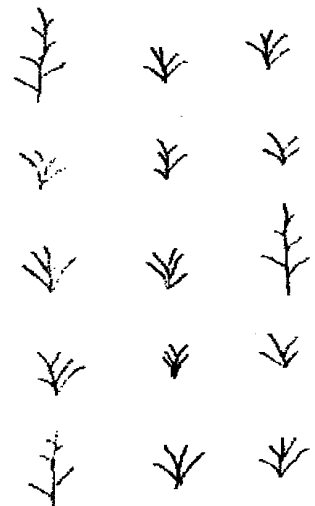
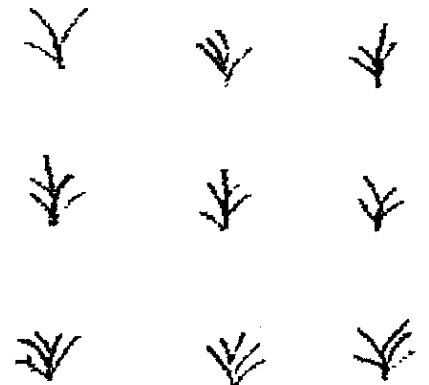
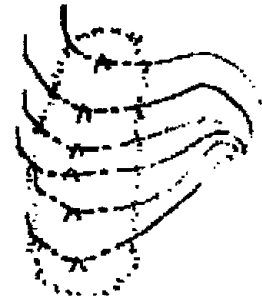
VII. Preparation of filbert nuts is usually by air drying the nuts for about a week, crack, and eat. Many people like roasted filberts. Filbert butter may be produced like peanut butter. Done properly, roasting filberts heightens their flavor. Place a double layer of in shell filberts on a cookie sheet and roast for 10 minutes in an oven preheated to 325°F/ 170°C. Cool **outside** the oven until warm; crack and eat. Cooling in the oven, or mounding hot in a bowl, will over-cook the nuts. Filberts roasted like coffee can be brewed like coffee. Filberts may be substituted for almonds or English walnuts in many recipes.

VIII. Filbert wood is much like elm. If fresh cut it can be bent to shape without cracking. Tree hazel can produce veneer, but the main use of tree hazel is as landscape trees where a tall tree with white corky bark, and glossy leaves is desired.

IX. **Propagation** of filberts in Ontario/NY is by growing seedlings of superior selections. Often one or two seedlings in a group of ten will be comparable to the selected seed parent. First evaluation of seedlings is possible 5 years after planting. Breeding of filberts can develop catkin hardiness, glossy leaves, kernel quality, production, blight resistance, and a single stem tree form. On the West Coast filbert propagation is by tip layering, then stooling. Tissue culture is increasing. Tip layering filberts involves; growing a clonal bush, removing its top in spring, thinning regrowth to about six healthy stems, then, when tall, hook them into the ground with 8 in./20 cm. coat hanger wire staples, and cut/peel girdles, and twist wire below girdle. Tips are drawn from underground. IBA underground in slits aids the rooting. A young clonal bush will raise healthy stems when 3 ft./1 m. whips are bent to a loop in the ground. If you own a good seedling which sends shoots, these shoots will often start in a tree shelter if cut off 6 in./15 cm. from below ground, even if no IBA is applied. Hilling the bush with hard wood saw dust, wire girdles on shoots well under-mulch, slitting and IBA treating above the wire, helps. This saw dust could be high organic like potting soil with the same effect.

A. Reasons for layering local filbert selections:

1. Filberts root easily in high organic soils.
2. Selections need distribution for testing and recognition.
3. Filberts on their own roots assure that all shoots are the same variety.
4. Bending stems down can benefit the mother plant by bringing more stems into full sun light.
5. If suckers start out from underground, the underground bark is ready to root. Sticking these suckers in a tree shelter is a successful method of rooting them. The trouble is that some filberts send underground sucker so much that they could never grow a single stem tree.



B. Factors limiting local filbert layering:

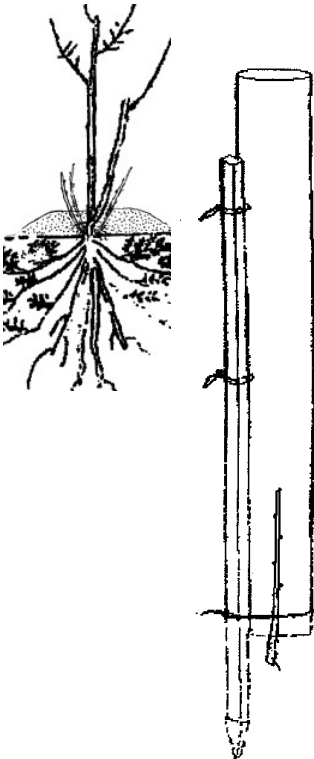
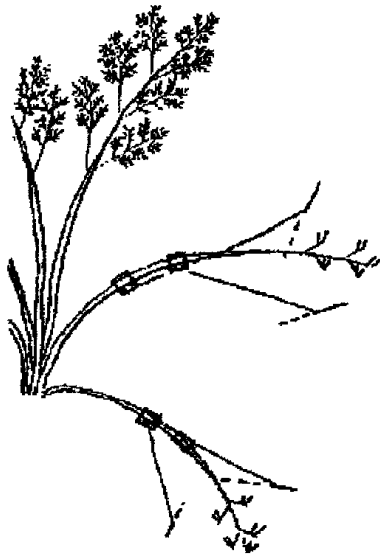
1. Our growing season in Ontario is shorter, harsher, and less sunny than at the long season, maritime western groves, which slows our rooting. Consequently, two seasons are needed before the same strong plants can be taken up. Roots should start rapid growth in late May when the soil temperature reaches 68°F/20°C. However, our cooler, wetter season favors small layers.
2. Owners of selections don't want to lose crops. Layering their bushes would have to be non-destructive.
3. Stems have to be trimmed back one year before layering, to obtain rapidly growing shoots.
4. Rabbits and mice often destroy bent-down stems.

C. Method for layering local filberts:

1. After harvest drive a stake and draw a filbert stem out and down until it is knee high. Necessary materials are: metal fence post, plastic coated fiberglass clothes line, and, for snaring stems, clamps cut from car tires, drawn tight with stove bolts.
2. Prune the stem back to produce several whip ends 1/2 in./1 cm. in diameter. Rub out all buds which arise more than 5 in./12 cm. below the whip ends which are to be buried. Maintain rapid growth from shoots to be layered by rubbed out side buds until mid-summer.
3. After grass has grown out 4 in./10 cm. spray the area where the stem will touch down after Roundup herbicide in an acidic spot spray .
4. After the herbicide spray dries, spade the touch down area. Mix in 2 lb./1 kg. 12-12-12 granular fertilizer plus 2 lb./1 kg. of bone meal and 2 cubic ft./50 l. of peat moss.
5. Weeks later, at mid-May pin the bases of the growing shoots to the ground. Coat hanger wire bent to 8 in./20 cm. staples may be constructed for holding down the whips. Bury the whips by hooking the stems into the ground with 8 in./20 cm. coat hanger wire staples, girdling with fine copper wire past staples, then IBA underground in slits for rooting within inches of girdle, turn the tips up out of the soil, vertical, if possible.
6. Mound the soil at staples and shoots. Covering the rooting area with potting soil. Near optimal temperature for filbert root initiation is alternating temperatures 68°F-80°F/20°C-27°C. By late June spray with Roundup with-a-bit-of simazine as a directed spray on weeds in high organic soil. Strong rooted filberts for resale may be taken in the fall, or fall of the following year. Keep up broadcasting granular fertilizer as you would for a regular transplant.

D. The tree tube shelter method of rooting filberts:

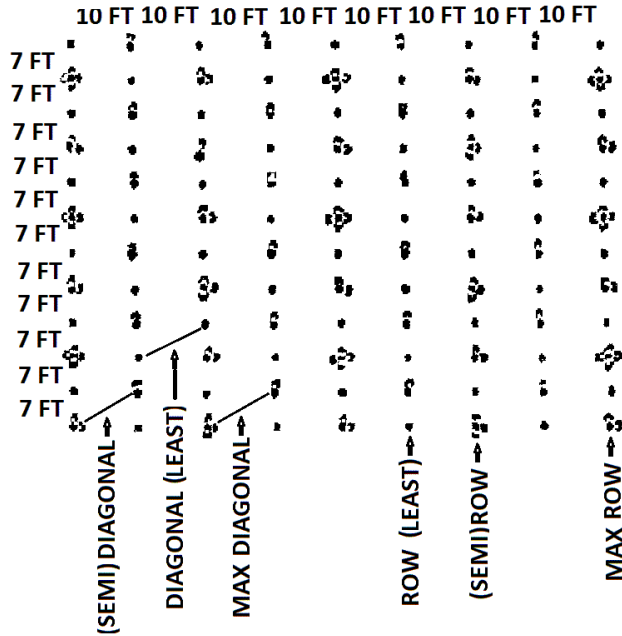
1. In early spring sever shoots from underground-arising shoots, cutting as close to the trunk as possible. These cuttings do not have to have roots, but have to have at least a bit of yellow bark which is bark produced under ground.
2. Re-cut the root tip to a wedge. After using an IBA dip recommended for filbert, stick and irrigate cuttings 6 in./12 cm. into dark (organically rich) garden soil. Only the yellow bark will send roots early enough to produce healthy starts.
3. Typically, stake a 75 cm. tree growth shelter over the cutting, keep moist.
4. Move the cutting and shelter to a permanent location in fall. FILBERT 51



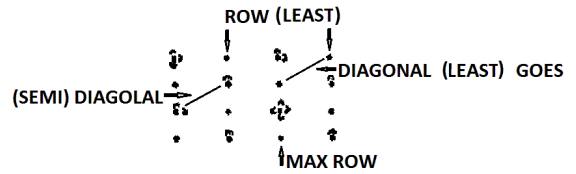
X. The thinning block, drawn diagonally below, is constructed from several spacing factors: tractor and equipment free movement, blocking west wind to warm orchard, contain 16 trees and thin to 1. The maximum diameter of a productive filbert tree is determined to 12 in./30 cm., butt ratio yields 1120 sq. ft. per block, or 39 trees per acre. We space trees closer in north-south rows to help moderate west wind, speed application of pesticides, and ease machine movement and intercropping between rows. Current recommendation is to plant filbert trees to a maximum height of 25 to 35 feet, thus select trees to be on 25 to 35 feet on centers. Interspace with seedlings, or alternate with seedlings and inter-crop. We should not try grafted filberts, but use the long lived and productive selections on their own roots and able to sustain large crops. Expect to move selections using tree spades when crowding occurs.

FILBERT/HAZEL / PERSIMMON / PAWPAW / C mas / APRICOT / ALMOND	BLOCK FT X FT	LAND AREA SQ FT	NUT TREE THIN DIAMETER,		TIMBER TREE THIN DIAMETER,	
			"START DENSITY" AT 30 SQ FT / Ac LIMIT CM	"INCH"	"END DENSITY" AT 60 SQ FT / Ac LIMIT CM	"INCH"
1ST THIN	10 X 7	70	7.6	3.0	10.7	4.2
2ND THIN	20 X 14	280	15.0	5.9	21.3	8.4
3RD THIN	30 X 21	630	22.6	8.9	33.5	13.2
4TH THIN	40 X 28	1120	30.2	11.9	42.7	16.8

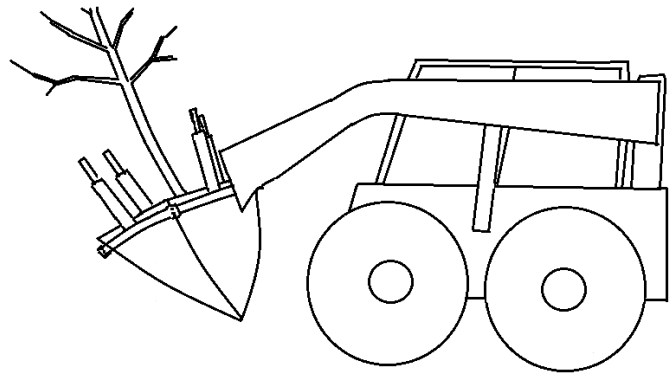
FILBERT ORCHARD SPACING FOR THINNING TO 40 BY 28
 1120 SQ FT PER BLOCK
 -AT STRESS-
 LOG BUTT COVER LIMIT = .069 % NUT / .138 % TIMBER



16 FILBERT TREES ARE THINNED TO ONE TREE,
 1 TREE ON 1120 SQ FT / 40 FT BY 28 FT.

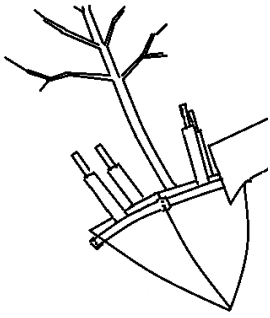


- 1ST THIN REMOVES DIAGONAL (LEAST) 8 TREES GO
 - 2ND THIN REMOVES ROW (LEAST) 4 TREES GO
 - 3RD THIN REMOVES (SEMI) DIAGONAL 2 TREES GO
 - 4TH THIN REMOVES (SEMI) ROW 1 TREE GOES
 - MAX ROW BECAME PERMANENT 1 TREE STAYS
- 16

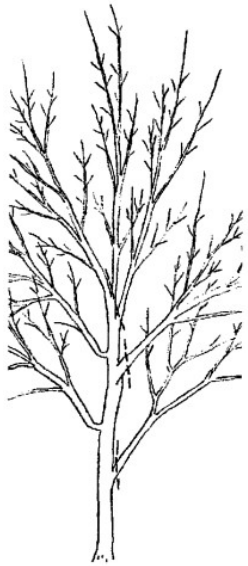


16 TREE FILBERT SPACE THINNED TO 1 (SPACE 40 FT BY 28 FT / TIME 10 YR TO 40 YR) IF GROWTH RATE IS 1 CM PER YEAR

TREE COUNT	BUTT AREA	DIAMETER / AGE
1	1. CM	10. CM
2	.8 SQ CM	78. SQ CM
3		20. CM
4		30. CM
5	3.8 SQ CM	390. SQ CM
6		1570. SQ CM
7		3535. SQ CM
8		707. SQ CM
9		4TH THIN
10	7.8 SQ CM	3140. SQ CM
11		3RD THIN
12		2ND THIN
13		
14		
15	11.7 SQ CM	1170. SQ CM
16		4710. SQ CM
		1ST THIN



1. The spacing chart, plotted above, is constructed from the below spacing factors.
 - A. Approximately .0667% butt area for bearing= 30 sq. ft. per Acre=1/1500. This ratio for best bearing is max fruit ratio by fruit growers (50% shade shadow.)
 - B. Approximately .1377% butt area optimum fiber= 60 sq. ft. per acre=1/3000. Fruit has declined, and the fiber (log) production rate has just maxed, indicating the start of tree stress. This goes with 70% shade on the ground.
 - C. Decline in both nut and fiber production shows real need to improve light in the grove, and indicates some injury to the trees.
 - D. Tree spacing has to change due to growth competition. This dovetails with the need to sort out selected seedlings. Odds are that in a group of ten selected seedlings one will be exceptional enough to be made permanent. These seedlings usually retain bearing when old.
 - E. Selections change. More good selections are coming out, probably from Rutgers, which will be propagated on their own roots. Tree spades are available to fall move these trees on your orchard without transplanting shock after your final selection.
 - F. The production rates of filbert trees may be less than fruit trees, but they are much longer lived, more valuable nuts, mechanically harvested, built for cold storage.
 - G. Drastic pruning can maintain production by allowing most light efficiency in the orchard while delaying the removal of trees. As filberts crowd and shade each other, energy conversion decreases, thereby reducing nut production. If drastic pruning is delayed until butt density reaches the point where fiber production decreases, nut production can be reduced by more than one quarter. More important, very little pruning is expected with select filberts on their own roots because of ease of moving them. Maintain 50% noon shade on the orchard floor.



XI. Many filbert selections are locally grown and evaluated. The 1976-77 winter was harsh, and few filberts bore. However, several of the Gellatly selections bore. Heavy production was reported on a filbert just north of London. Morden Experimental Farm in Manitoba also had a good hazelbert crop in 1977. Gellatly's tree hazel hybrid selection, Faroka, is highly rated for EFB resistance, hardiness, leaf and nut quality, and production. It has female flowers along the peduncles which hold its male catkins. These bisexual catkins are not the typical all male catkins, but like most bi-sexual catkins are linked with super vigor and nut production. Ennis filbert has no EFB resistance, but, like Faroka, is so max quality and production a nut that it is max grown if no EFB, and will be retried if EFB is eradicated here.

XII. Tree hazels hybrids may, in the long run, out produce filberts. Their main drawback is too southern in tree hardiness, and more than 8 years to start production. Tree hazel hybrids can approach native hardiness, and have large, glossy, healthy leaves, and the ability to pack a firm, tasty, melting kernel in a short season. Deep root systems and glossy leaves make tree hazels better equipped for summer water stress.

XIII. Projects with filberts:

- A. Develop hardy tree hazel hybrids.
- B. Select among seedlings and varieties for the firmest, melt-in-the-mouth kernels.
- C. Select for mid September ripening, late September drop.
- D. Propagate on-their-own root selections.
- E. Re-test the theory that growing EFB infected autumn olive and filbert together will end EFB on both. At the same time look into bacteria phases that might coat, and protect the vascular systems of filbert and autumn olive.
- F. My project is to set out a grove of Ennis filbert with scion wood from the Filbert Genebank Repository in Corvallis, OR at my planting where Eastern Filbert Blight has died (though this may be temporary, just as the lack of EFB in Eurasia may be temporary.)

AIR LAYERING & STOOLING

ROOT GENERATING CHEMICAL:

IBA = INDOLEBUTYRIC ACID-HORMODIN 2, ROOTTONE, HORMEX

I. Air layering is used to generate roots on selections so that they are on their own roots. There are good reasons to grow filbert, juneberry, heartnut, chestnut, mulberry on their own roots, and persimmon/pawpaw off their root cuttings.

Filbert, juneberry, and injured chestnut sucker freely to renew stems. Thus, they need to be on their own roots, and not graft stocks. Heartnut and chestnut often display incompatibility at graft unions. Heartnut is difficult to graft, and once grafted, the discontinuity at the union is unsightly rather than lethal.

A. Verne Luvall of Galesburg, Illinois worked on this method to quickly air layer filbert. He had been grafting blight resistant filberts on seedling stock, only to lose them when blight invaded the stocks. After treating and wrapping a softwood shoot, it is forty days until the layer is severed, potted and moved to a lath house, tree shelter, or greenhouse.

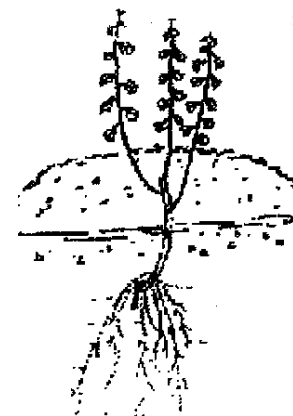
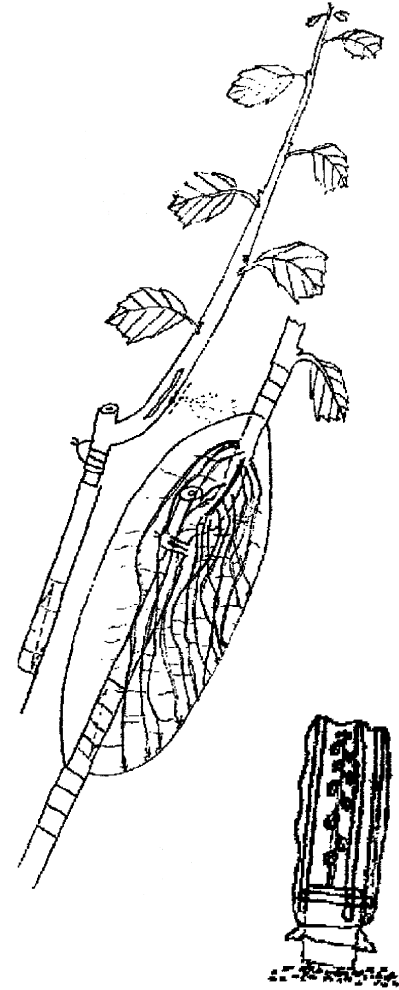
II. Air layering filbert:

A. Dormant graft in early May. The union must be strong so the saddle graft, or English graft is used. Remove all sprouts from the stock as they appear. The root stock must be vigorous and the graft must be set on a strong, young shoot.

B. After 15 cm. shoot has grown in late May, girdle the scion 1 cm. below the sprout with tight turns of wire. Cut a 0.5 cm. ring of bark from below the bottom turn. If cambium reattaches, root generation may fail. Strengthen the graft union with several turns of Blenderm first-aid film.

C. Apply 8000 ppm IBA in grain alcohol to the base of the greenwood shoots, enough to wet them. They will appear dry in about a minute. Hormodin 2 on chipped bark also works. The instructions say to dip and tap off excess Hormodin from cuttings. IBA is often incorporated in grafting compounds to stimulate callusing. Because the rate of IBA used to callus is more than the rate to root, there is a limit to the potency of IBA to use. In grafting compound I substitute tallow (usually deer fat) which breaks down to IBA. You should google the IBA formulation for rooting recommendations.

D. Soak, then wring water from a double handful of long strand sphagnum moss (used to hold fishing worms alive). Wrap the moss around the scion to leafing above the treated area.





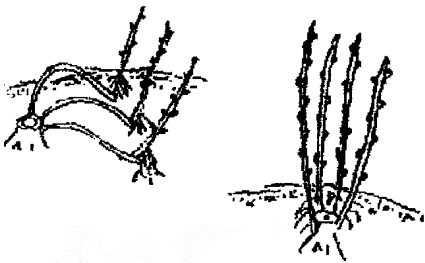
E. Wrap the moss with several turns of food storage film. Seal top and bottom ends of the film to the stem with first aid film/ electrical tape.

F. Wrap the film with aluminum foil. If rain soaks the moss, it must be squeezed out again until roots take over to drain it. If watering is necessary to keep the moss moist, add some weak liquid fertilizer. Check daily until you get a feel for how fast the moss dries.

G. Sever successful air layers 40 days after treating, or by noting a hand full of roots. Many filbert roots should be 2 in./5 cm. long.

H. Pot the air layer, and move it to a lath house, or tree shelter (a still, humid, semi-shaded environment where it is watered and fed.) Temporarily (for 1 or 2 weeks) cover the filbert with plastic food storage bag to prevent wilting.

I. Transplanting into tree shelters is adequate once some roots have formed on the air layer, less if it is fall, and leaves have fallen as in October.

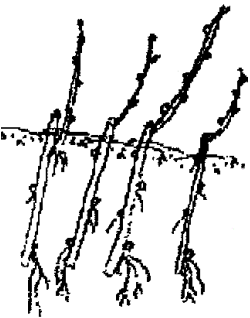


III. To Continue **stooling**:

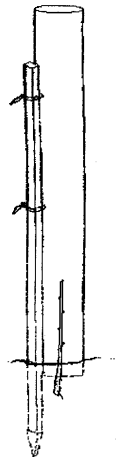
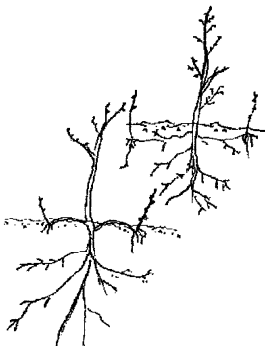
A. In later years sever part of the rooted filbert with some roots attached in March.

B. Bank new sprouts with highly organic potting soil. Expect these filbert to fully root inside two growing seasons.

C. Heartnut, and mulberry will root easily, like filbert, but some varieties are tricky. Chestnuts and Illinois Everbearing mulberry do not root unless made to sucker from underground buds, usually blind buds/adventitious buds. Dr. Loy Shreve developed this sprouting technique for walnuts, and finds that it works with most hardwood species. Underground adventitious cuttings are taken after they have grown out 12 in. /30 cm.



1. Persimmon and pawpaw root cuttings are taken in April, and sprouting is started in a warm car, or window box, once bundled in white plastic bags with long strands of wet white newspaper (Roll a full sheet of newspaper into a 2 inch strip, wet, and wind around the bundle.) A few tiny earth worms in the moist/muddy bundle keeps out mold, and encourages sprouting. Sprouts start anywhere on the root, so planting requires re-cutting some roots to have sprouts peaking above soil/ in loose mulch in late May/early June.



HEARTNUT AND HEARTNUT SORTS

I. Heartnuts (*Juglans ailantifolia* var. *cordiformis*) are hard shelled Japanese walnuts which can release whole kernels from unfractured shells because kernels of selections are smoothly tapering, and shells split into halves. Other heartnut sorts are hybrids with butternut (*J. cinerea*) or Manchurian walnut (*J. mandshurica*). As the population of butternuts declines due to imported diseases the population of heartnuts and Manchurian walnuts increases. However, this is untrue for Montreal through the Prairie Provinces. Butternuts and their hybrids are alone able to endure these short seasons, and arctic cold spells. Hybrids like Mitchell are being bred to replace the butternuts of the North. These heartnut/butternut types all have shallow roots easily injured by traffic. The bark diseases of butternut easily get into their surface roots, and finish the tree, unlike the bark disease of chestnut.

II. The name heartnut describes a valentine shaped nut whose shell silhouettes its valentine shaped kernel. Heartnuts taste most like butternuts; a kernel mild in texture and flavor, rich in oil that greatly resists going rancid, but without the aromatic tang of true butternut. Year old heartnut nuts develop a tang like Brazil nuts.

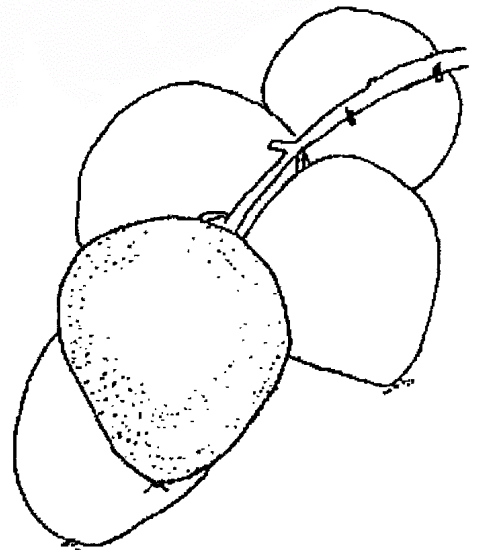
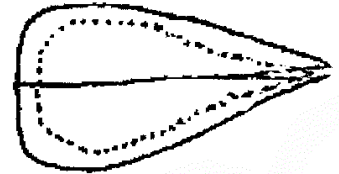
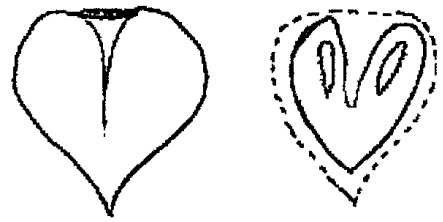
III. Crackability makes heartnut selections household nuts. The Fodermaier variety can part its shell when quickly dried. Sealed nuts release, "crack", when pressure is applied across their shoulders. Vice-grip pliers, those with curved jaws, are ideal for cracking heartnuts. The varying sizes, shapes, and textures of shell make the half shells decorative, and useful in crafts.

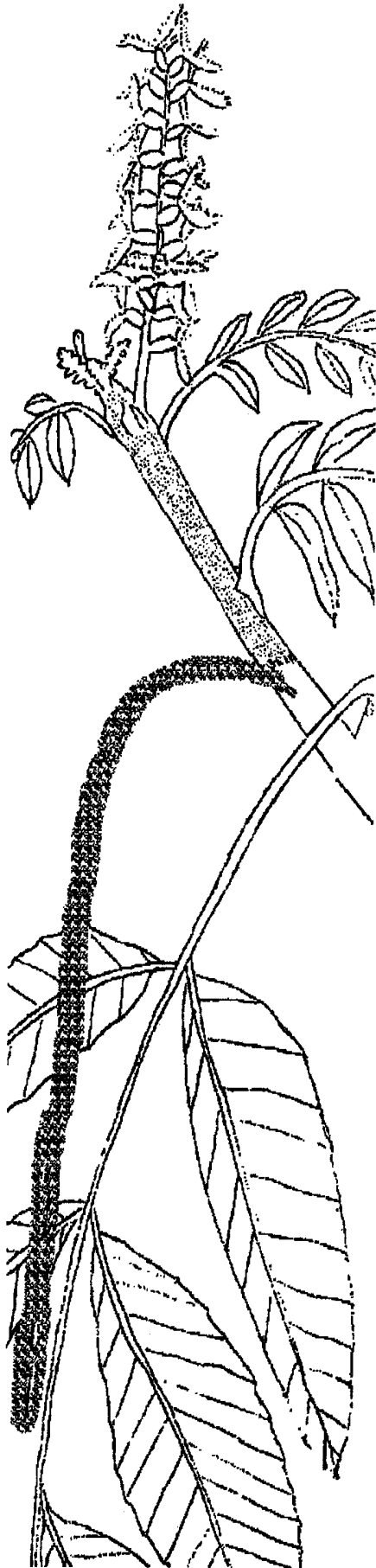
IV. Hulling heartnuts is conveniently done by hand, once the hull has dried. Green hulls are fuzzy and sticky. Nuts drop in the hull and will ooze the black walnut stain while wet. Typical black walnut hulls become leathery upon drying and must be hulled while yellow-wet. However, heartnut hulls fray like old paper upon drying. Some dry retaining form like jujubes, as some black walnuts do, but most shrivel as they dry. The spines on butternuts hold onto its husk.

V. Heartnut kernels are most like English walnut kernels in their uses, taking on the spice flavors in cooking. Both have a soft enough texture to be used in baking without dicing. English walnut kernels are lustrous, and frilly while heartnut kernels are a yellowish tan (if the pellicle is left on), and a smooth valentine shape. Home cracking of heartnut selections is faster than English walnut cracking. English walnut shells fragment and, if the kernel falls free of shell, it usually clings to the nut septum.

VI. An interesting pattern emerges in the following listing of walnuts. By going from heartnut to Persian walnut to black walnut to butternut:

- A. Nut production gradually decreases.
- B. Crackability gradually decreases.
- C. Hardiness would have gradually increased if Persian walnut was pulled out to least hardy.





1. Heartnut (*Juglans ailantifolia* var. *cordiformis*)
2. Persian walnut (*J. regia*) (English walnut)
3. Heartnut sort, hybrid (*J. cinerea* x *cordiformis*) (Butternut) or (*J. nigra* x *cordiformis*)
4. Japanese walnut (*J. ailantifolia*)
5. Manchurian walnut (*J. mandsurica*) (a "black pecan" of thick shell)
6. Black walnut (*J. nigra*)
7. Butternut (*J. cinerea*) (a "black pecan" of thick spined clingy shell)

VII. Hardiness is easier to find in heartnut than Persian walnut. Most Persian walnuts are maritime, or nearly tropical sorts which suffer more insect and disease damage than heartnuts. Hybrids of most walnuts have been grown. Heartnut hybrids are often successful. However, Persians hybrids are a mess, and it is noted that the Persians accumulate sterility, susceptibility to bacterial blight of walnut, thick twisted shells, poor hardiness with no retention of the black walnut flavor. (Exceptions are several Persian walnut hybrids by Kenneth A. Dooley of Indiana, and Clifford H. Dabb of Utah.)

A. Morgan Arboretum near Montreal has mature heartnuts and heartnut hybrids. Full heartnuts suffer dead limbs and wounded trunks scarred by frost cracks, and winter sun scald injury. These selections are from J.U. Gellatly of the Okanogan Valley in B.C. Gellatly selected for highly productive trees. Some production and landscape quality were gained, but hardiness, and nut quality is less than adequate. We have done further breeding and have good nut quality, but have not taken these for testing in Montreal. The one Persian-heartnut hybrid appears an exceptionally hardy, healthy, heartnut sort, at a smaller red clay brick building at McGill University in Montreal.

B. Heartnuts are hardy inland. Hybridizing them with butternut (or black walnut) offers:

1. Hardiness increases against fluctuating, and arctic temperature.
2. Heartnut increases resistance to leaf hoppers, butternut canker, and anthracnose.
3. Heartnuts are productive (their hybrids are semi productive.) Flower stalks often contain 20 nut-lets. 1000 kg. per hectare of in-shell nuts (300 kg. kernels) is nominal.
4. Heartnut carries the crackability traits of a flat shell, and tapering kernels.
5. Hulls on some heartnut sorts release on drying while puffed up to help hand hulling.
6. Hybrids can attain the vigor of northern poplar, and produce some nuts.
7. Heartnuts contribute large lush foliage even more tropical looking than Ailanthus, the tree of heaven.
8. Heartnuts attract butternut curculio, and need the help of bare ground underneath for birds, or short grass, and near "city" lights.

VIII. Heartnuts have landscape quality for people who want tropical appearing trees. The heartnut variety CW3 retains its leaves all season in a lustrous green condition. Some varieties start to discard

lower leaves at mid season. When leaves drop only the center rib remains for raking. The leaflets disappear. Heartnut leaves and roots contain far less juglone than black walnut, but their drooping branches and heavy shade is as killing as juglone to many plants.

IX. Recently the best butternuts to appear have been heartnut hybrids (for example Craxeasy is a butternut hybrid.) This change over will increase for two reasons. Butternut is being decimated by butternut bark and root diseases, and any spiny shelled nut seems accepted as a butternut. Hybrids have a distinct suture line, and are sometimes flat and heart shaped (examples: Mitchell, Dooley, Filzinger.)

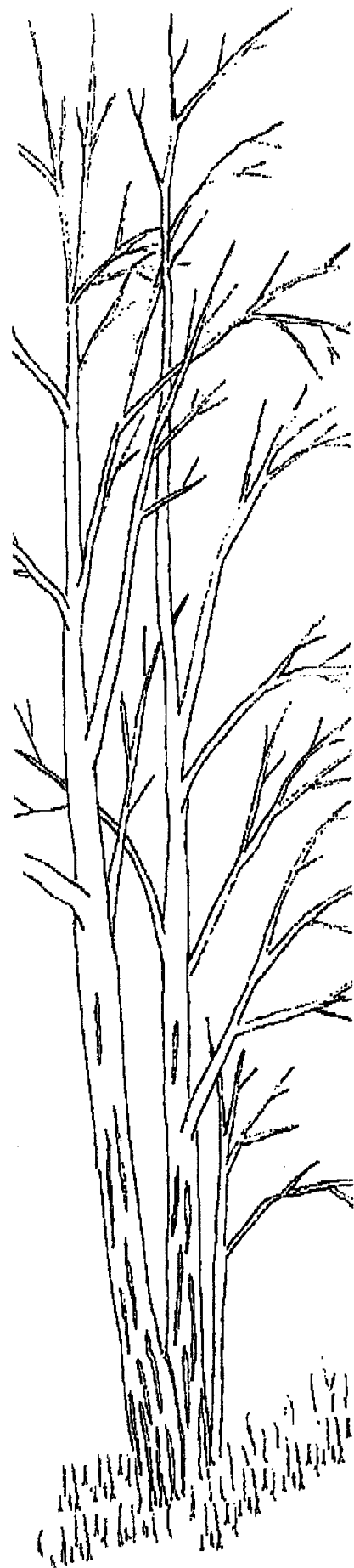
A. Comparing heartnut trees to butternut trees, heartnut trees are low headed, spreading laterally from a single short trunk. Butternuts are much more erect, often seem to be excessively limby, and often have several trunks. Hybrids, especially the G. H. Corsan hybrids at Echo Valley Park in Toronto, are massive timber type trees. Juvenile heartnuts are similar to juvenile European chestnuts because they grow rampantly until bearing begins, then growth slows by two thirds. The butternut hybrids in E.V.Park likely retain immense growth due to abortion of nuts. Young heartnuts have terminal branches that look like broom handles/crow perches. The bark below the redish fuzz on the current seasons growth is yellowish. Butternuts have many more branches which are much thinner, about half inch/1 cm. thick. Current season's bark is greenish with little fuzz. Mature bark is light grey on both species.

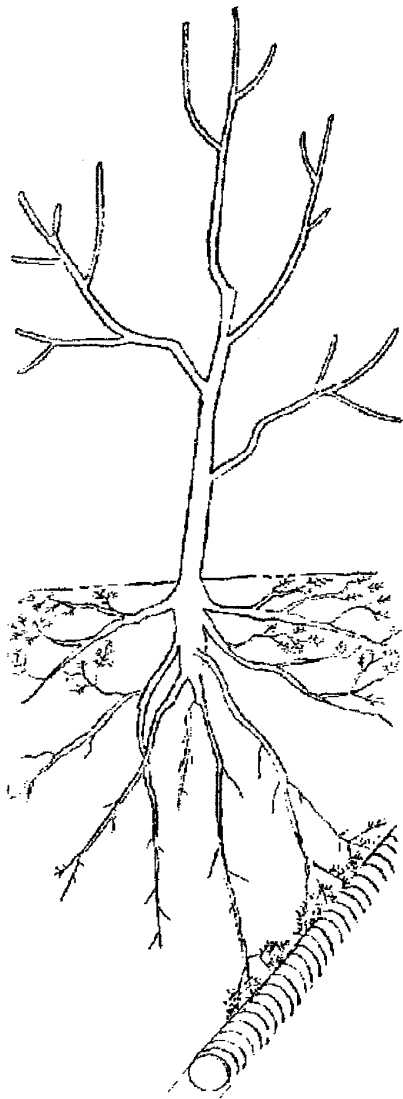
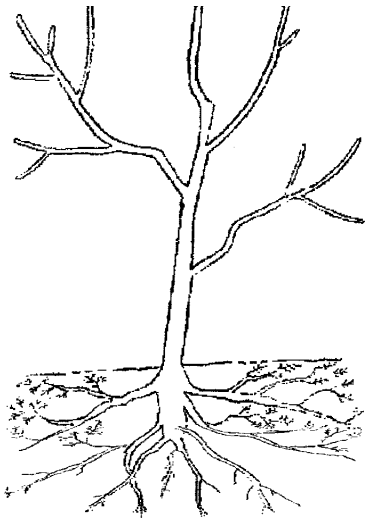
B. Butternut canker fungus (*Siroccus clavignent - Juglandace*) is resisted by few butternuts. The wounds are much like chestnut blight cankers which kill patches of bark . These spread to girdle the tree. Butternut cankers exude a dark ooze. Chestnut blight cankers start as brown to copper patches where the bark breaks to expose sap wood. On chestnut no ooze is present, but under wet conditions the dead areas are covered with orange spore pimples, and horn-like, orange blight fruiting bodies.

C. Four serious walnut diseases are resisted by hybridizing:

1. Butternut canker described above.
2. Anthracnose fungus, (*Gnomia leptostyla*) or leaf blotch which defoliates black walnut during hot humid weather, and red fescue grass.
3. Bunch disease (mycoplasma not identified), or witch's broom which is uncontrolled vegetative sprouting, and growth. Mid-season buds burst into growth as they form. This odd growth is not winter hardy, looking like a witch's broom.
4. Stem dieback fungus, (*Melanconium oblongum*) where the butternut or black walnut declines from stem tips toward the trunk. The tree eventually dies from root rot and center rot. This decline is similar to filberts declining with eastern filbert blight except no filbert root rot. On filberts spore bodies form neat rows of dots/dashes, running down yellowing, and dying filbert stems. In walnut dieback the eruptions form on thin walnut bark in a chicken pock pattern, dots at 1/8 in./3 mm. centers. The fungus is feeding well below the eruptions as can be tracked by stunted growth and yellow foliage. It is assumed that Persian walnut is resistant

HEARTNUT 58 to stem dieback,





but hosts walnut blight disease on brown flecked winter-injured branch-lets, to surprise us as worthless graft wood.

a. Stem dieback and bunch disease are slow spreading, and are often treated by sanitary pruning. Whole sectors of a tree are removed because the disease extends below visible symptoms and several branches become involved before noticed. Growers from Central Illinois to Pennsylvania observe that bunch disease appears, then disappears in their trees. Groves of heartnut have died out in the South and in California. Surviving groves have been fertilized with potassium, and zinc which limit bunch disease.

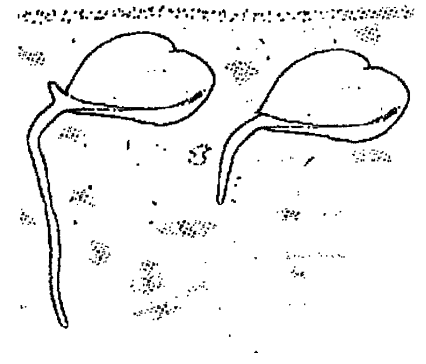
b. Good cultural practice with heartnuts is to fertilize in early spring to wash nutrients down, and push the greening of the grass. Foliar nutrients should be added to the tree sprays as the season continues. Heartnuts have large roots near the surface which must not be injured in cultivation, or orchard traffic. Though local heartnuts have not suffered other than the temporary bunch disease, the trouble farther south is worrying. We look to the fruit industry for ideas on control of fungal and bacterial diseases. Bacterial blight of walnut is controlled by copper containing chemicals as protect California's English walnut industry. Earl Douglass gained a control for chestnut blight in the orchard by trying fungicides, especially those for black knot in plums, but new regulations have discontinued and reformulated same. Filbert blight is getting control advice, now that Oregon is faced with the disease.

5. Thousand canker disease, *Geosmithia morbida*, of black walnut is invading from the Southwest.

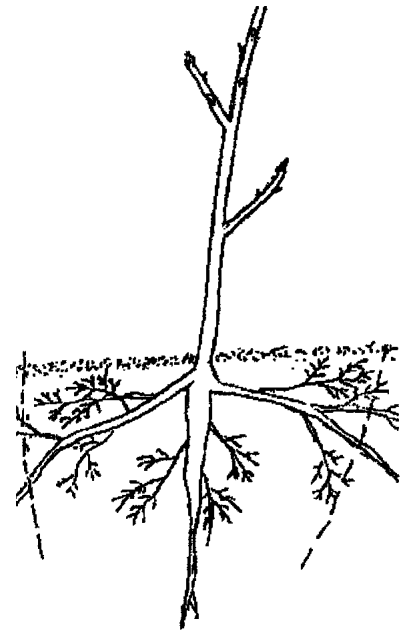
X. Germination of heartnut seed has less need of cold moist stratification than needed for butternut or black walnut. However, stratification always pushes up a more vigorous plant. Heartnuts have thinner, less tightly sealed shells, and usually germinate 90% after a month of cold moist stratification. An abandoned refrigerator (with catch removed, and nail holes struck through the back for drainage) can be laid on its back on the ground, and mounded with earth to make a good walnut storage chest. Nuts should be gathered moist and left un-hulled, but fluids drained off. Open the chest to rain in fall. Nuts should be planted out in the spring before nuts split, allowing the white root (radical) to poke out and down. Plant the nuts an inch/2 cm. deep. Heartnuts and all the walnuts are very tolerant of simazine herbicide.

Y. Squirrels, rabbits and other rodents/birds must be kept out of newly seeded nuts. They take the seed even after the trees are up. Crows and jays will feast on Persian walnuts and filberts, but take no notice of heartnuts, or black walnuts, usually. Squirrels need a double layer of the orange, diamond, plastic safety fence spread as a tanglefoot where hawks are handy.

XI. Transplanting heartnuts is much like transplanting filberts although heartnuts are slightly taller, set farther apart. Both send major roots out at ground level. Before digging out, the large surface roots should be located and cut to retain a broad root pattern. Failing this, the tree is stunted because side roots are cut too close to the tap root, or the side roots pull shards from the root crown. After saving a few side roots transplanting is highly successful. The surface roots are first to warm, heal and begin functioning. All too often black walnuts, hickories, hicans and pecans lack surface roots and do not prosper initially when transplanted into cold northern soils.



A. Use tricks to establish trees which arrive without side roots. Plant smaller trees because most of the root is near the surface and retained. Mulch with plastic film to prevent evaporation and warm the soil (clear film warms deepest/fastest). Start grafted trees in tube pots (cut from 6 inch/15 cm. plastic pipe, or duct film) and give bottom heat, warmth from sun (not too much baking sun) and still air. Set out the trees by mid-June by pushing tree and soil out into the planting hole, exiting the tube root first. Don't pull the tree up from the tube.



B. Transplants with a large tap root and weak side roots can be potted and heeled-in, covering (only the root) with dark soil, kept moist, and started into recovery before careful planting in June. With the extensive side roots of heartnut and filbert these tricks are built-in.

XII. Encourage the surface roots of heartnut because:

A. Surface soils are biologically active. They are aerated, organically enrichable, and easiest to feed with compost and broadcast fertilizer.

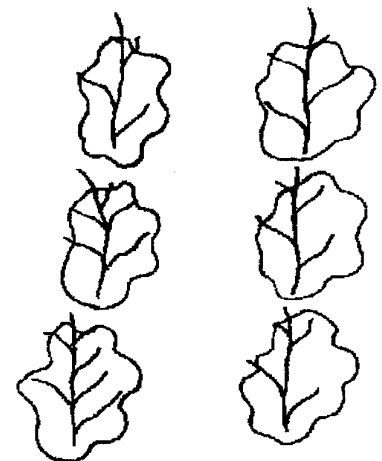
B. Heartnuts are the most likely nut to prosper (next to pine) where a rich moist soil overlays a high water table, hardpan, bedrock or cold subsoil.

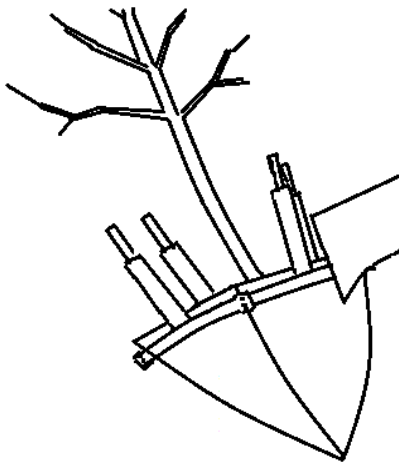
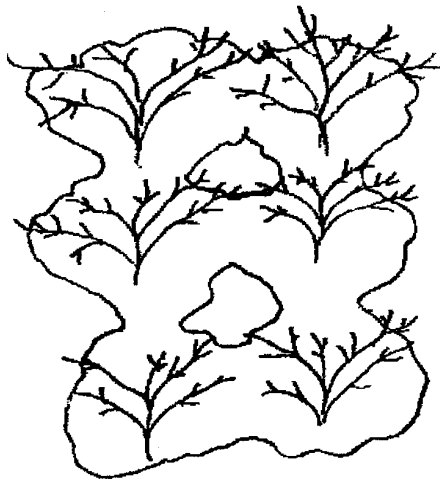
1. Problems with the surface roots of heartnut:

a. Surface roots are easily injured by dripping inoculum off walnut canker, traffic and cultivation.

b. Surface soil has to be rich in calcium and organic matter, fairly moist, and free of competing roots, especially fescue grass, the unusual occurrences for native nut trees being transplanted into open space.

c. Surface roots of walnut (especially black walnut, if that is the rootstock) give off their own weed killer, juglone, which injures strawberries, tomatoes, pine trees, apple trees, etc. Under heartnut trees these plants will be shaded out .



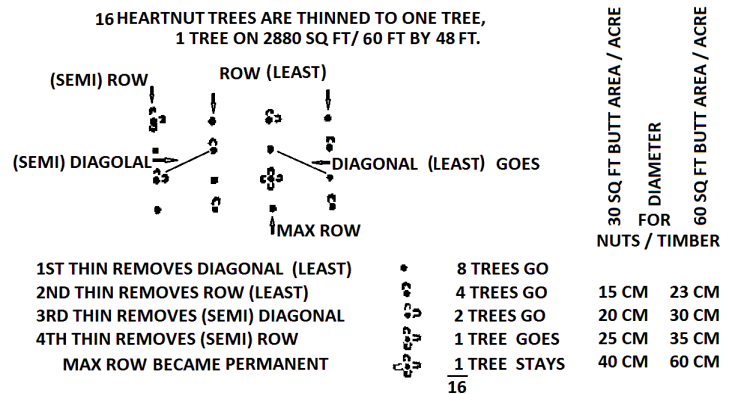
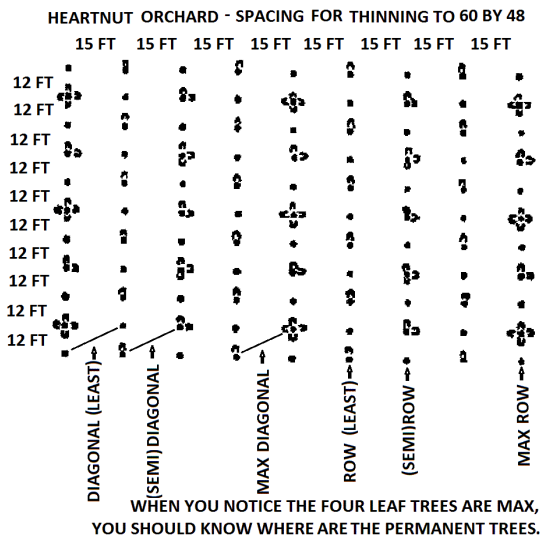


XIII. Spacing of heartnut trees is very similar to the spacing of bush filberts, but farther apart. Light efficiency is best when 30 ft²/2.8 m² of butt area are growing on an acre/4000 m² of land. When hybrid heartnuts are grown for timber (maybe crotch wood) they should crowd each other by growing 60 ft²/5.6 m² of butt area on 4000 m² of land. The shadow on the orchard or forest floor would be about 70% of the area. Heartnut has a flat head with good light penetration from above. The forest hybrids will be forced tall by crowding. Heavily cropping heartnuts should grow to 50 cm. diameter in fifty years. Timber types would about double this growth rate, but need crowding, thus could use a similar planting spacing. Initial spacing would be halved, like black walnut.

A. Timber growers should delay thinning until the lesser diagonal and row can be removed at a usable 30 cm. diameter. Pines should be set out four years ahead of timber walnuts to produce adequate windbreak and crowding. Some pines may be tended as Christmas trees. Heartnut hybrids might kill off the remaining pines after benefitting from the crowding by being forced tall.

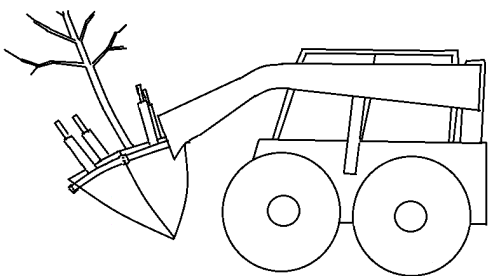
XIV. Selling heartnut hybrid logs may be tricky. All the walnut lumber can be stained to match black walnut. They have the same qualities of wood (probably not the curl of Persian or curly black). Yet, even black walnut is an uncommon log in Ontario.

Consequently, there are few buyers. A few logs could best be sold to a local wood worker through a custom sawyer. Truckload qualities would probably be sold into Indiana, the big walnut timber state.

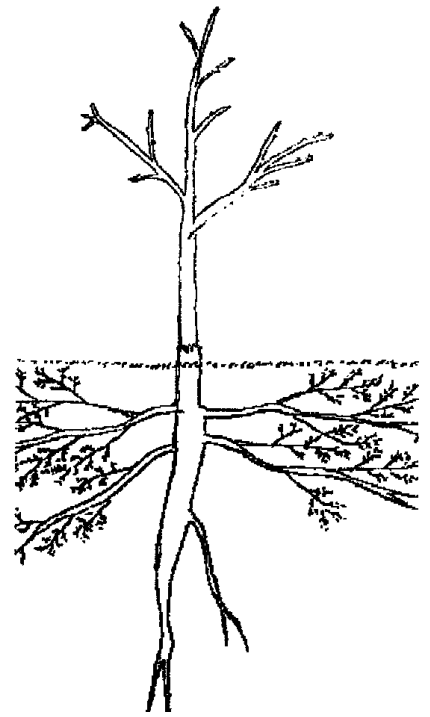


16 TREE HEARTNUT SPACE THINNED TO 1 (SPACE 60 FT BY 48 FT/TIME 10 YR TO 50 YR) IF GROWTH RATE IS 1 CM PER YEAR

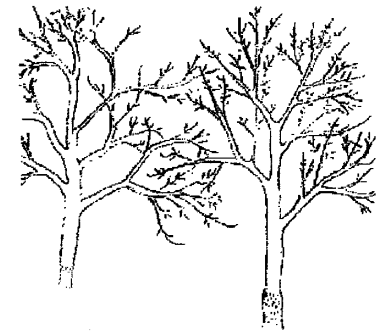
TREE COUNT	BUTT AREA	DIAMETER / AGE
1	10 CM 78 . SQ CM	20 CM 314 . SQ CM
2		30 CM 707 . SQ CM
3		40 CM 1256 . SQ CM
4		50 CM 1963 . SQ CM
5	390 . SQ CM	1570 . SQ CM
6		3535 . SQ CM
7		6280 . SQ CM
8		9815 . SQ CM
9		
10	780 . SQ CM	3140 . SQ CM
11		7070 . SQ CM
12		
13		
14		
15	1170 . SQ CM	4710 . SQ CM
16		10605 . SQ CM



XV. Heartnut breeding may yield a Clonal rootstock for walnuts. Clonal means a reproduced original, unique, ortet tree. The root system might be the same as is important in pawpaw, persimmon, and filbert where new replicants are generated from root spruting. Usually clones are grafted, and only the fruiting part of the tree is top worked/grafted. Without cultivars on clonal rootstocks, planting plans are warped by trees growing at different rates with the trees which produce large nut crops being crowded out by their faster growing, vegetative neighbors. J.U. Gellatly showed that heartnut would layer and stool, an exception among walnuts. Paul Sauber finds heartnut a valuable rootstock for Persians (also in France). However, Lawrence H. MacDaniels warns that many Persians will overgrow heartnut, and cause a structurally weak unions, certainly the overgrowth of the top looks hazardous. However, tissue cultured heartnut look most likely.

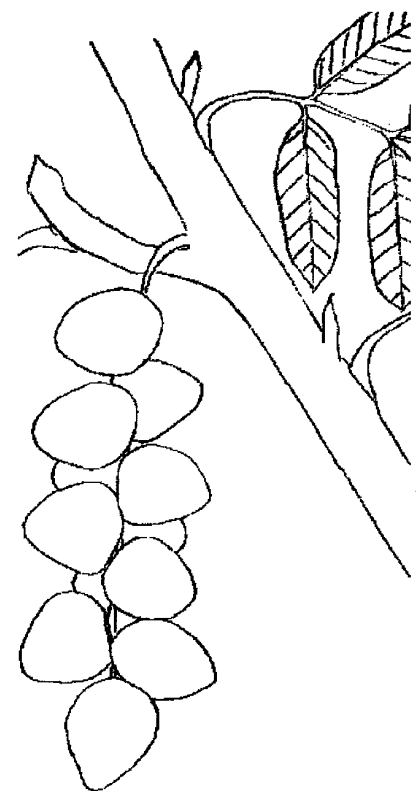


A. Because Clonal apple root stocks are used in orchards, and not forests (vegetative growth very good in forestry), their counterparts would be used with nut producing walnuts (fruiting and fruit production very important in orchards.) Think size control, dwarfing, irrigation and feeding of compact (weak?) root systems, and the highly productive dwarfish Persians, like Colby. Together these produce an orchard of compact trees.



XVI. To introduce adapted heartnuts, the Society of Ontario Nut Growers distributed heartnut seed from the most noted Ontario grove, the Elton Papple grove near Brantford. Roy Metcalfe accumulated statistics from the 1976 SONG heartnut seed distribution. A few seedlings are succeeding into Agriculture Canada hardiness Zone 4 (Haliburton, Ont/Watertown, NY, by the Lake). In 2010 big changes have seen Ernie Grimo and fellow nut growers with new varieties, and larger plantings growing heartnuts.

A. The Papple heartnut grove produces bumper crops of nuts. It missed cropping only in 1981 probably due to our Arctic Christmas of 1980. The trees appeared uninjured, but did not fruit. At the Weschcke nut grove near River Falls, Wisconsin few of the 1981 nuts set and matured, but the heartnuts bore as did Ohio and Patterson black walnuts, native chestnut, and a small proportion of the hickories and Winkler hazel seedlings. Heartnuts near Preston, Iowa (top of hill), St. Louis, Missouri and Harrisburg, Pennsylvania bore annual crops.



XVII. Some heartnut cultivars are:

A. The Etter heartnut is short season, high quality and highly productive. Though impossible to graft (or so it seems), it has many selected seedlings which were grown out here. Etter trees in Pennsylvania have had bunch disease, but make progress against it on a droughty chestnut site.





B. Fodermaier is a twin of Etter except larger of nut, and much later ripening, like Rhoads too late ripening in the North.

C. R. D. Campbell has produced fine seedlings from Etter nuts. The selection CW3 is top of the line with a heart shaped nut that dumps kernel even in a drought year. Drought years are known to pinch the kernels in many varieties, Bates/Faust especially, so that they no longer taper and dump. CW3 never lost a crop even during the test years of the early 1980's. It has the latest bloom and hardiest terminals. If it has high sugar sap, I would nominate it for being an Etter x Canoka hybrid. It retains its lowest leaves green all season, unusual for a heartnut. Other of Doug Campbell's fine Etter seedlings are CW1, CWW and Szukis (a Campbell seedling fruited by Doug's neighbor).

D. Campbell's West is valentine shape, and a twin for Locket. No drought pinching of their kernels (deeply creased between lobes, yielding no air pockets). Campbell West produces flowers as a very young tree. It is producing nuts as an "under-story" tree...unusual.

E. The Brock heartnut is productive and has the plumpest kernel which drops free. Brock is also late ripening. Where pollinated by butter-nuts and hybrids, Brock produces many hybrids which appear to be Craxezy again.

F. Wright produces a large kernel bound usually tightly in a round shell. The shell must be smashed to extract kernels. It is a step back-wards by heartnut-with-air-space shell design. Round nuts usually have air pockets which balloon out the shell during drought to pinch kernels. Those that can pinch due to air pocket expansion (lack center crease) are Bates, Westfield, Schubert, Calender, and Wright. Calender is Elton Papple's best producer.

G. Schubert and Imshu are mother and daughter from seed brought back from Korea. Ken Schubert from near East St. Louis, IL lost the original tree to a late freeze which killed foot long new growth, and put the tree out of synchronization with the season. The Schubert nuts are plump hearts like Brock. Pyke has a crease, and no air space.

H. Pyke is one of a series of very flat heartnuts which has kernel taper nearly 45° toward shell inclusion, like Imshu, and the large nut, Stealth...all most extractable kernels. It is very early ripening with a very thin shell. It would be a twin of Rhodes except Rhodes is longer, and very late ripening, mid October in Niagara.

I. Blunt is an exception among heartnuts. It is a seedling of Covell Manchurian with the same blunt nose, and sweet taste, tight in the shell, but cracks out whole, being a blockier nut with short tongue septum.. This seems what we need for breeding to remove the sharp nose on heartnut (See back cover.)

J. The hardy Mitchell Hybrid is a productive with a lot of nut shell, spiny a bit like butternut, but the shell is flat and crackable like heartnut,

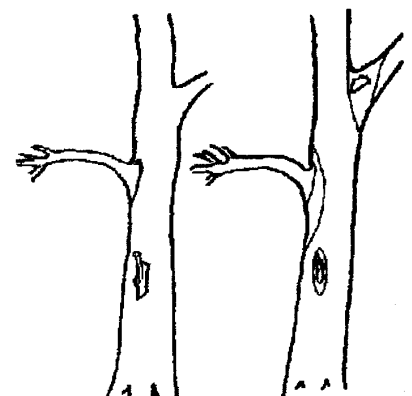
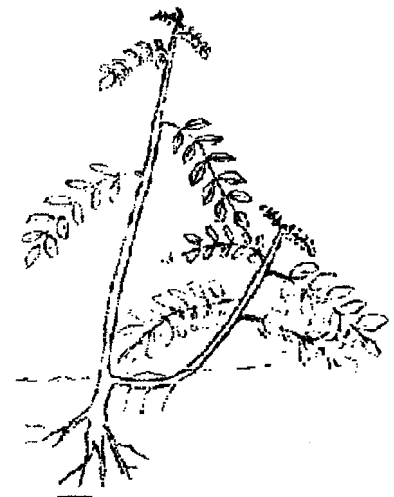
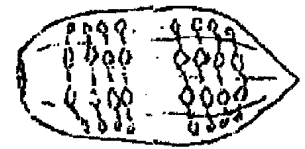
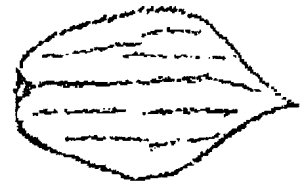
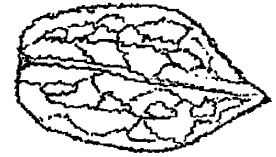
kernels a bit tight in shell. Similar hybrids are Filzinger and Baker Hybrid, which are not as hardy, and do not dump kernel...not easy cracking.

K. The Sauber Black Walnut Hybrid has a rough black walnut type shell which cracks like Wright. Sauber hybrid is a controlled cross with Fish heartnut, and the shell binds one kernel lobe as does Fish. One seedling of Sauber shows its shell can improve with breeding.

L. The Covell Manchurian Walnut is a productive "black pecan" which cracks like a heartnut, though its taper is hardly noticeable. The shell looks like a very large in-shell peanut, though length makes for a sealed septum that cracks off center, often trapping kernel. The original tree is winter-sun injured, hollow, and half dead on droughty clay near Lockport, NY. The kernels are bright yellow, and slide out whole when the crack is down the center of its long septum tongue. The distinct peanut depressions on Covell shells indicate that these are different from the other heartnuts/Japanese walnuts. Covell and its seedling Blunt are sweeter than heartnut. Covell and the Baker heartnut rapidly gain flavor toward Brazil nut taste with a several months of warm, dry storage. Blunt is a round nut, but opens an open shell using side pressure, and divides better than Covell which too often needs black walnut cutter help to extract whole kernel.

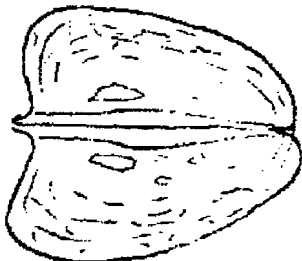
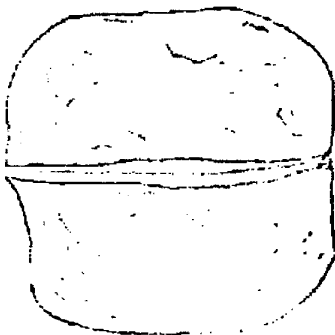
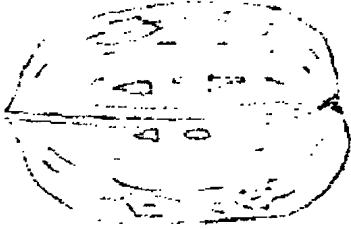
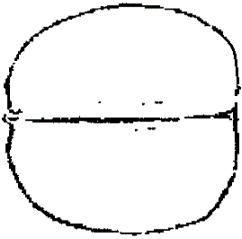
XVIII. Future work with heartnut:

- A. Stool heartnuts, Etter (not knowing why Etter refuses to graft).
- B. Breed heartnut sorts to the quality of CW3, Etter, Imshu, Stealth, Campbell West. Stealth seems to produce hybrid seedlings, so far.
- C. Determine breeding partners which produce quality offspring for nuts or timber.
- D. Evaluate heartnuts for disease resistance.
- E. Evaluate rootstocks which propagate by layering or stooling.
- F. Build on the Chinese work of evaluating the nutritive oils in Manchurian walnut. Google heartnut oil description on the internet.
- G. Evaluate the remarkable storage life of heartnuts which seems to improve flavor with length of storage.
- H. Evaluate the edibility of green heartnut fruit in pickling, and food preparation, though they have a narrower window of opportunity for gathering soft shells than Persian walnuts. Use a pin shoved through the nut to check for shell hardening as in Persians, and the same pickling process. Eating pickled walnut could be a better way of getting the nutraceutical juglone than rubbing it into skin.



PERSIAN WALNUTS

(ENGLISH, CARPATHIAN, RUSSIAN, GERMAN, ETC.,
MANREGIAN, HIMALAYAN, CHINESE, POMEROY,
CRATH CARPATHIAN)



I. Most Persian walnut (*Juglans regia*) trees which are growing in Ontario are seedlings grown from nuts imported by a missionary to Poland, Rev. Paul Crath. These Crath Carpathian walnuts have been growing since the 1930's, and the original trees have reached their full potential.

A. Where and how these trees are growing and producing is very interesting to SONG members. Though the information will never be complete, most successes are reported within 1 mi./2 km. of the shore of the Lakes, from Kingston, clockwise through Midland. There are productive trees away from the Lake Shore. Inland trees are often troubled with winter injury and late spring frosts. However, if they are in town and among buildings they are usually productive after a mild winter. Very few are growing like hickories out in farmer's fields.

B. Persian walnuts are prized for their nut, and shade tree qualities.

C. Persian walnuts fill their nuts under cool conditions. Productive trees are growing within sight of the Lake in Belleville, Goderich, Owen Sound, and Collingwood, Ont.

D. Exceptionally hardy trees produce yearly crops near Brantford Locust Hill, Woodstock and Mitchell. There are groves of Persians in the Finger Lakes Region of New York.

E. Persian walnuts are thin shelled, and often large. They can self hull, and fall to the ground bright and clean.

F. A few Persian varieties are self pollinating. Only when male and female flowers are timed to overlap will a walnut tree self pollinate. Most trees avoid selfing by the genetic timing that separates bloom, except in a very large, old trees when some flowers overlap.

G. Seedlings from selected parent trees often retain high nut quality, but hardiness and production vary widely.

H. Persian walnuts are fast growing with the first nuts to appear in six year old, 4 in./10 cm. diameter trees.

II. Limiting factors in Persian walnut production are:

A. Typical Persians need good air drainage when away from town, in a Lake moderated climate, a cool spring to hold back leaf flush and bloom until danger of frost has passed, and a long fall with several frosts before the plunge into winter. Persians generally look very poor until the tree is 50 ft./15 m. tall, and in town in short grass, which makes their evaluation tricky.

B. Away from the Lake, under-drainage is critical for extensive root development which insures fall dormancy and winter hardiness by allowing uptake of fluids during cold.

C. Persians grow best on 5 ft./1.5 meter deep gravel loam soil.

D. The native soil of Persians is decomposed limestone. Locally they prosper on fertile soils of pH 6.3 to 6.8. Liming gets seedlings off to a good start, and extensive roots locate lime in the subsoil.

E. Productive groves usually need spraying for husk maggot, although a crusty soil, orchard sanitation, and baits reduce this need.

F. A Persian orchard will need several sprays of copper per season against Bacterial Blight (BB), and trees resistant to BB of walnut. BB can be mistaken for winter injury, but not where it grabs onto the nuts. Look for BB on scion wood where it looks like brown freckles, and do not graft with freckle wood which is spoiled. BB resistant trees can be full of black nuts, twigs, and leaves; because BB thrives where trees are frost injured (a yearly problem) to start BB spread in congested, airless, hot/humid locations.

G. Persians rarely self pollinate so that three Persians should be brought into a yard for cross pollination.

H. Mix plantings with pines (for pine aerosol BB disinfection and grass killing), and making Persians hardy at very windy sites. Persians need a drying wind as at a normal wind site.

I. Leaf hoppers suck juice from terminals and leaves during June and July. Hoppers shy away from large objects like the large tree itself, and houses, which also helps explain why Persians do best in town near houses.

J. After cold moist stratification Persian walnut seed, like other nut seed, produces the quickest germination and strongest seedlings. However, total germination is sometimes higher after cold, dry storage, and adequate cold water soaking.

III. Germination of Persian walnuts produces a thick stand, if after cold, airy storage, nuts are soaked in cold and aerated water several days ahead of planting. Look at hospital supply blue plastic storage bags that vent-in oxygen, and retain minimum water in cold storage.

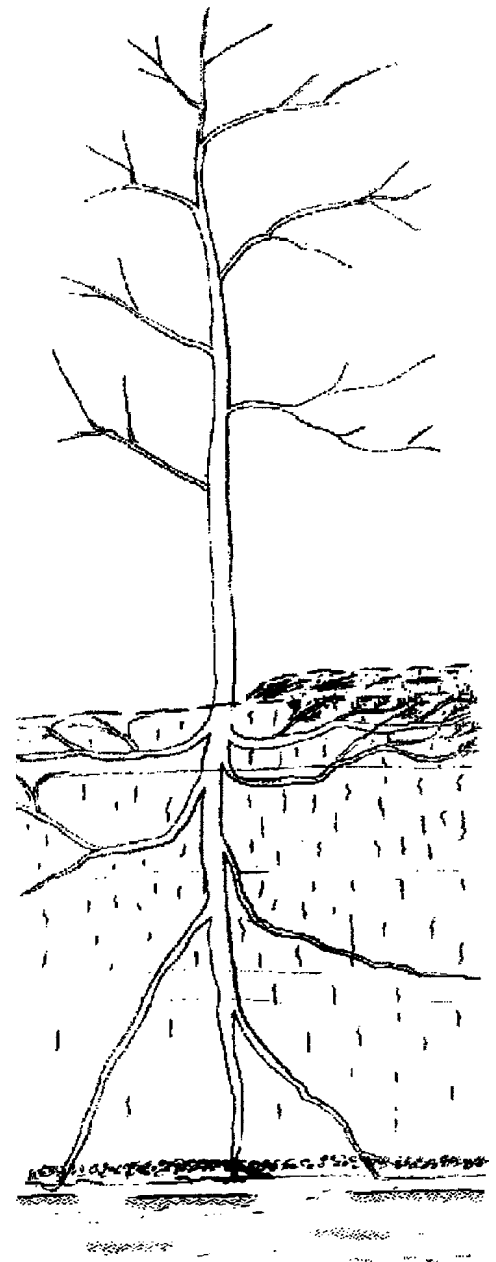
A. Gather nuts from the best quality, most productive trees in the grove. Never store in plastic, unless nuts go directly to airy refrigeration near freezing.

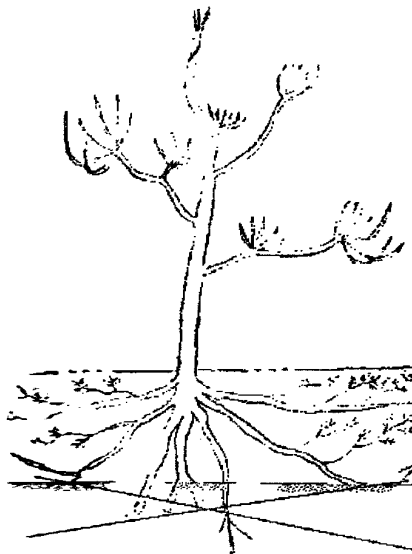
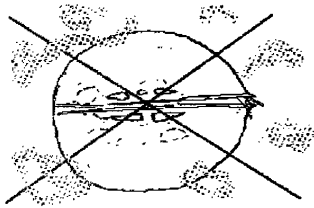
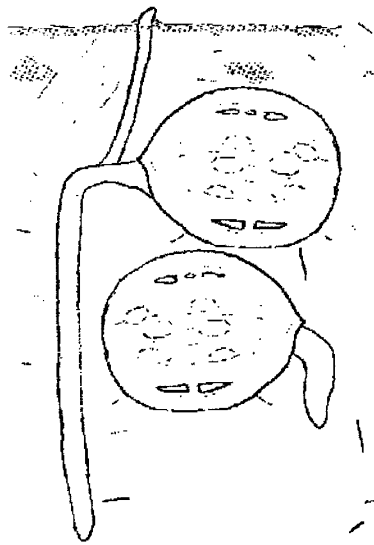
B. Gather and dry nuts as soon as possible.

C. Dry nuts by air circulation and dehumidification. Nuts may be hung in wire baskets in a dry breezy space for longer than a week, or spread on newspaper in a dehumidified room for five days. Be sure kernels are palatable before moving the nuts to winter storage. Nuts that taste even slightly rancid do not germinate.

D. Fall plant (You do not need to hull Persians which you fall plant, but store the Persian walnuts in cold, airy, rodent proof containers.) Good results are achieved by storing dried nuts in perforated cans in an enclosed porch or attached garage. Where mice and squirrels are a problem, delay fall planting as long as possible while baiting, trapping, and clearing away habitat.

E. While planting the nuts, position them carefully. Place each nut on its side with the suture line vertical. The point of the nut is horizontal. This configuration allows even a weak root to emerge semi-horizontally, and push downward, followed by the stem which emerges as the soil warms, and pushes up vertically. If the rise in soil temperature is rapid, the stems grow vertically before out of the shell unless the shell has opened above (and below for the root.) A vertical suture line divides the shell below the radical and above the stem, allowing them to exit without being trapped by the shell. Too dry nuts in spring often suffer roots, and stems, twisting around in the shells.





F. Cover the nuts with 2 in./5 cm. of earth.

G. In spring the dry seed has to be soaked before planting. Soak the nuts by daily draining and refilling fresh water over the nuts for almost a week. Planting should be as early in spring as conditions permit working the soil, and planting seed in the ground. Usually the seed is soaked outside at 32°F/0°C. Warmer temperatures speed the soaking process, **and mold**, especially in warm semi-dry nuts.

H. Cover the rows with two layers of diamond orange plastic construction safety fence. Bait for mice. In spring spray Roundup-Simazine as soil cracks (around mid-May) with the start of Persian sprout emergence. Crows and squirrels pull these bright green sprouts (some red, some green) from the ground to get the sprouting nuts. Try to plant seeds near where humans, or hawks are active. I rely on hawks out of large perch-trees. Once crows start, they never forget. Agway and Co-op stores sell an effective orchard bait. The broad leaf weeds can be pulled after rain, their vigor limited by simazine.

1. Simazine is an inexpensive, effective, and long lasting herbicide for use on most nut seed plantings. On unworked or loamy soil simazine stays within the top 2 in./5 cm. of the soil. Most of the common nuts (except filberts), and tree/bush seeds display rapid growth and very high tolerance to simazine. To be effective, simazine has to go on early. There is about a month's delay between application and control under moist conditions. There is slight to no effect from simazine when weed roots are deep. It can wash over the ground, carried by heavy rain run-off, to cause trouble in neighboring vegetable rows. Solicam is an expensive "simazine", but economic, and works without the month delay in the cool and cold of fall.

IV. Persian walnuts need a special site, suitable for fruit growing. Persians which grow inland, away from the Lakes, are hardy trees growing on well drained gravel loam. Only plant Persians which can maintain dormancy. A good orchard site will shed late fall rains. December of 1976 contained weeks of warm wet growing weather, followed by a deep freeze. Many Persians were destroyed which were previously hardy. The Carpathian strain of Persians endures **deep winter cold** probably better than any other strains except Russian. Do not be fooled. Carpathian, a maritime nut, builds winter hardiness slowly, succeeds by quickly moving fluids to warmer tissue at seasonal change. Waterlogged soil and a cold snap often causes ice to form in the wood of Carpathian trees. A split through the trunk is a common result. Low ground, especially hollows and toes of hills, must be avoided because of frosts, and poor water/cold air drainage. Late spring frosts will kill early "**bud swell**" and flowers (flaring bacterial blight) on Persian walnuts, especially the quick to move Carpathian. The fluids that quickly rise into warmed tissue move up to swell buds in early spring, following which there is no escape from freezing. Put the Persians on ridge, hill top, brow of a hill, or high bank locations. At these sites cold air will flow down hill, and be replaced with warmer air during calm air, clear night conditions. High sites need irrigation.

A. Deep soil which allows 5 ft./1.5 m. of root penetration is necessary as with most nut trees. The surface soil should be between pH 6.3 and 6.8, and rich enough to grow a thick plant cover. Pre-plant treatment, one year prior to setting out trees, improves the site by liming, fertilizing, working, seeding with a legume mix, ditching, and mowing. Working-in bone meal/granular fertilizer at the tree pits is also advised the fall ahead (never mix in granular salt fertilizer at planting time unless it is sulfur coated), and look for infiltrated calcium lensing to be deep in the subsoil.

V. **Transplanting and maintaining** Persian walnuts:

A. After grass has grown out 4 in./10 cm. in the spring, no heavy rain shown coming for hours, kill sod in a 7 ft./two meter spot with Roundup + simazine. Add a bit of vinegar or sulfuric acid to the tank to be sure the mix is acid for the Roundup to be most effective. Spray at least half a day before digging. Walnut is not affected by simazine so use of a combination spray is often smart.

B. Dig the planting hole broader and deeper than the extended root system to be planted.

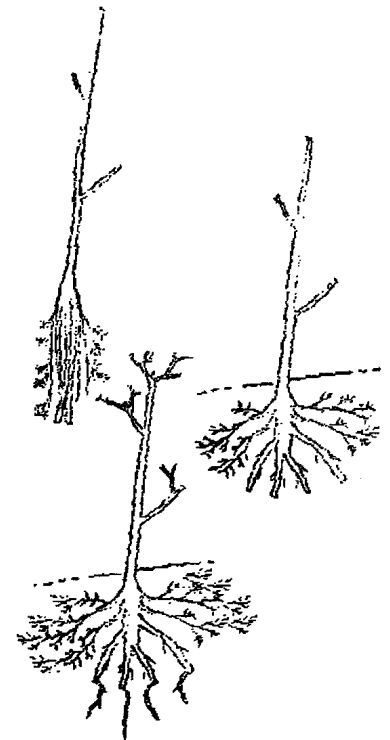
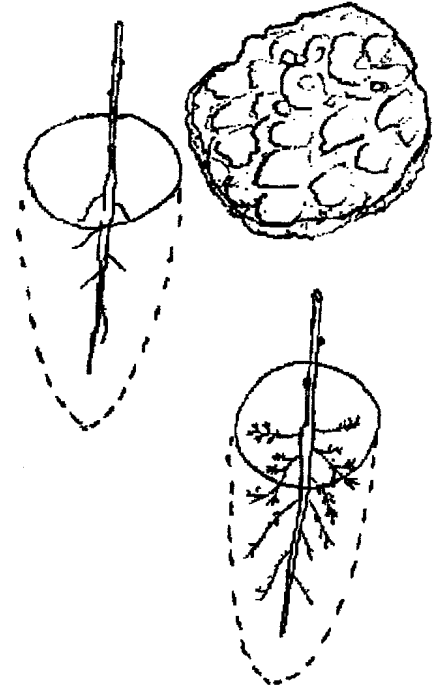
C. For a 3 ft./1 m. high transplant, mix approximately 2 lb./1 kg. of bone meal into the planting soil. (Digging and mixing in the bone meal plus the same amount of granular garden fertilizer the previous summer/fall is highly effective.)

D. Spread the root system and trim off dead and badly injured roots. Roots more than 3/4 in./2 cm. diameter, which have torn ends, should be pruned to smooth wedge ends. Do not let the roots dry off. Roots which look grown together, like straws on a broom, will resist spreading, but must be separated. Packing and stacking causes this unnatural congestion.

E. Place the root system in the hole so that the root crown is 3 in./8 cm. above the original ground surface.

F. Filter in the planting soil, while spreading the root system. Remove weed roots and grass clumps from the planting soil as you come upon them. A fibrous root system on your transplant indicates a healthy, well nourished tree. This tree can be ruined by wadding together the roots. Rather than wadding, it would be better to trim off some of the hair roots. Inexperienced planters often need supervising.

G. Tug on the stem and tamp to consolidate the soil, while keeping the roots extended. Rod soil between the tree roots with a stick, or shovel handle.





H. After all the soil is replaced and tamped, add brought in soil to hill the tree 6 in./10 cm. above the root crown. This mound will naturally disappear, or depressions at the root fill with mice. Mulch with clear plastic if you have it. Sunlight transfers heat deepest with clear plastic.

I. Stake a 20 in./50 cm. tree tube shelter over the tree, tapping it into the ground a few centimeters so that mice do not enter. Cut the top to stand over the transplant 4 in./10 cm. Squirt a bit of citronella lamp oil on the inside of the tube to discourage wasps, and on the wasp nest if it appears.

1. Eventually, wrap the stem with a tube of octagonal plastic garden fence to ward off deer rubbing, rabbits, wood chucks, etc.

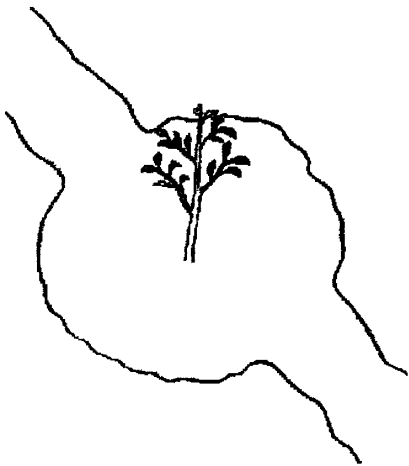
2. Trim the off dead leaves and branchlets as they appear. Seal wounds with Elmer's glue, or grafting compound type wound dressing.

3. Water with 5 gal./20 l. buckets to keep the deep soil moist. Soak a dry ground at each watering to get the water down to the tree roots.

J. Start broadcasting granular garden fertilizer (12-12-12 or 15-15-15 at 2 lb./1 kg per inch/ 2 cm. of tree diameter) right away and at 2 month intervals during the growing season. Broadcast away from the tree trunk and out past the branch spread, usually a spot four times the foliage shadow. The concentration of application should do harm to the leaves of grass and weeds, if they are wet. Any pellets contacting the tree bark must be removed before they burn the bark. You may find that September use of fertilizer will make some Persians tender in hardening off. Late rains and warm weather does the same, so seek hardy Persians rather than trying to save a Persian that cannot complete its season.

K. When weeds return, spray with Roundup + simazine. A Solicam + simazine mix at the first fall ground frost is the last spray of the season to weed kill on the cool, cold, and spring break-up ground.

L. In future years maintain a 7 ft./2 m. wide bare soil mulch around trees. Some simazine with the Roundup is cost effective. If intercropping is not practiced, maintain grass strips between rows. Tall grass sod (especially fescue) is injurious to walnut root/leaf/branch health.



M. In future years prune only enough to remove dead, rubbing and malformed branches. Maintain a conical shaped tree with the longest branches nearest the ground. Many Persian walnut trees maintain the conical shape naturally. The variety Colby is noted for this shape. Conical shape permits most of the terminal branches to fruit by eliminating shading of the branch ends. South-west injury, often a problem in Carpathians and other Persians which are quick to flow sap, is protected against by trunk shade from long low limbs. Descending limbs gather more light, storing more energy, than those that tend upward. Increased bending due to nut load helps increase sugar storage by drooping the limbs. Maintain less than 50% noon shade on the orchard floor by generous spacing to promote this condition. Even less shade is advised where bacterial blight of walnut is a problem...where a drying, stirring wind is necessary...where late spring frost spreads/"seeds" bacterial blight.

N. Once nut production is underway, after about twelve years, expect to fertilize with about 1000 lb./500 kg. of 15-15-15 fertilizer per year. Supplements will be determined by leaf analysis. Leaf analysis is tricky due to the ability of leaves to concentrate the minerals tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding. Mulching and keeping an active soil flora and fauna frees up bound minerals if they are present.

O. Begin removing trees before crowding occurs. First remove sick looking and stunted trees which are getting in the way of more promising trees. At eight years, or sooner, start removing poor producers. Trees which sucker excessively should be removed. The cause may be bunch disease, walnut blight, wet feet or genetic lack of hardiness. Top working such trees should be avoided.

P. Before harvesting nuts, prepare the orchard by rolling, cutting grass, raking, and removing debris which mix with and hide nuts.

Q. After harvest, leaves, downed branches, hulls and especially nuts should be pastured off, mowed with a mulching mower, shredded to prevent their use as winter homes for over-wintering pests.

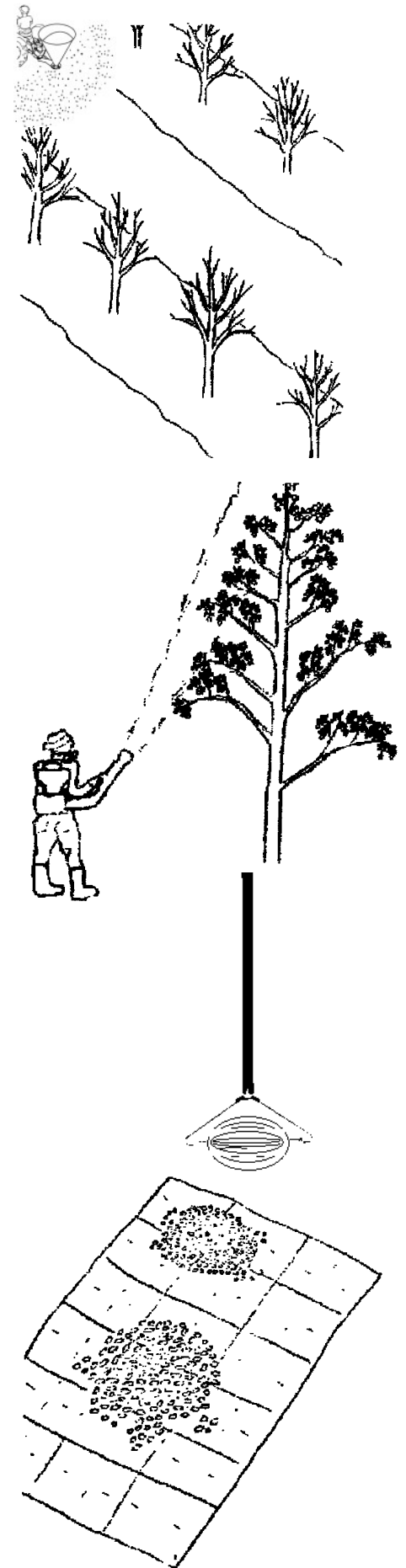
R. Learn to identify walnut husk maggot flies (small golden "deer" flies) which appear on, and lay eggs in the softening hulls of walnuts. Likely source is a pile of in-hull black walnuts. Survey using sticky cards, and spray with a recommended insecticide, if severe.

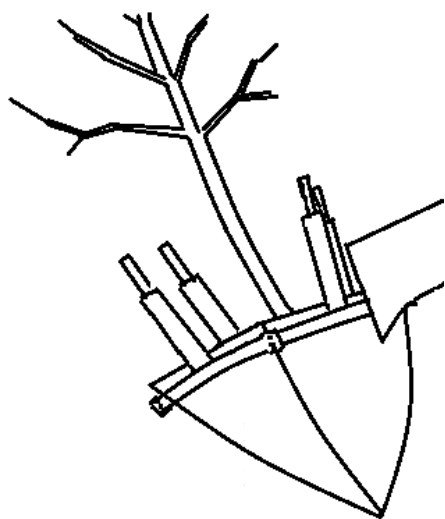
S. Learn to identify walnut blight (Black, dead patches and spots on current season's nut hulls, branch-lets, and leaves.) Remove highly susceptible trees. Spray at frost killed leaves, warm rain periods, at humid/ heavy dew periods, with Bordeaux mixture or other copper sprays that are recommended. Some people say to renew a spray before the wet period to remove the inoculum which would be splashed about in the rain, which is the reason we spray frost killed leaves.

T. Learn to identify walnut bunch disease (rampant sucker growths at terminals, uncontrolled flushing even at secondary buds, followed by severe winter injury). Persians and other walnuts often mask bunch disease with mysterious poor performance fixed by zinc and potassium feeding. Trees which have pale yellow leaves are candidates.

VI. Harvesting and storing Persian walnuts is as simple as picking the large bright nuts from the ground every few days. The new rolling coil hand machines make pick-up easy. Dry nuts for storage in a cool airy location. Commercial growers in California use Ethrel spray, and tree shaking to bring nuts down for a once-over/twice-over harvest.

A. Dry the walnuts under conditions similar to spreading in a single layer on newspaper in a dehumidified room for five days. Frosting, rather than heating is the secret to sweet northern nuts. Outdoor drying involves hanging the nuts in wire baskets in a stream of fresh air. After the nuts become quite crisp and palatable, they can go to winter storage. Store in rodent-proof, aerated containers in an unheated room, or enclosed porch. Freezing kernels in an air tight container provides long term storage for eating. That same containment in a heated room quickly produces the slight rancidity associated with some store bought kernels too long on the shelf. These nuts will not germinate.





VII. Persian (English, California, Carpathian) walnut recipes are in many cook books. Store bought walnuts often need the rejuvenation. Cooking brings up their freshness a bit, usually when they were **not** stored in a freezer. Ontario gathered walnuts are usually crisp and sweet due to cool ripening and a short period of cool storage. They are often enjoyed by eating out of hand. They impart a crunchy, nutty taste to cookies, cakes and candies. Persians will double for beef in hamburgers and meat loaf when mixed with egg and rice. The oil in nut kernels takes on the flavor of other cooking ingredients.

1. Persian walnut wood may be used for lumber and fire wood. Nut production may be supplemented by an intercrop of Christmas trees, and wood from removed Persians. Persian wood is blond, not dark like black walnut wood, but can easily be stained to match black walnut. Left blond it is Circassian curly walnut. All walnut wood is strong and highly crack resistant. Many Persian walnut orchards in Europe were consumed for gun stocks during World War II. Small chunks of walnut are used like oak for firewood.

VIII. Spacing Persian walnut trees is based on spacing observations of productive trees growing in orchards under Lakes' Region conditions. **The need to keep air flowing through the orchard out weighs the need to warm the grove , thus spacing is wider north to south between trees** (the same spacing as a black walnut/pecan grove rotated 90°.)

A. The most fruit are produced at the ratio 1:1500, .067%, butt area 30 sq. ft./ac., which should also produces the most nuts (approx. 50% noon shade on the ground.)

B. Doubling this ratio produces the most tree fiber at the expense of bearing (approx. 70% noon shade on the ground.)

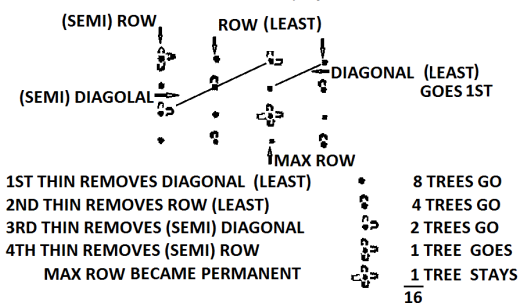
C. Decline in both nuts and fiber production is uneconomical, and indicates stress injury to the trees.

D. Tree spacing has to increase with time due to growth competition. This dovetails with the need to sort out selected seedlings. Odds are that one in a group of ten seedlings, from exceptional parents, will be exceptional enough to be made permanent.

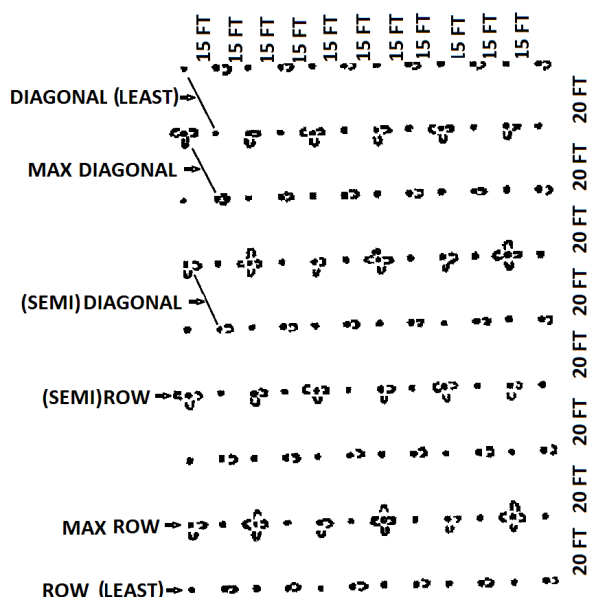
E. Tree spades are available to move large trees without transplanting shock. These spades could be used to move selected trees rather than chopping them down, though expensive and unnecessary except for super trees. Large trees droop, and close gaps in the canopy in only a couple years.

F. The years-until-maturity, and the production rate of Persian walnuts, are slower than fruit trees, but walnuts are much longer lived and their logs are much more valuable.

16 BLACK WALNUT TREES ARE THINNED TO ONE TREE,
1 TREE ON 4800 SQ FT/ 80 FT BY 60 FT.

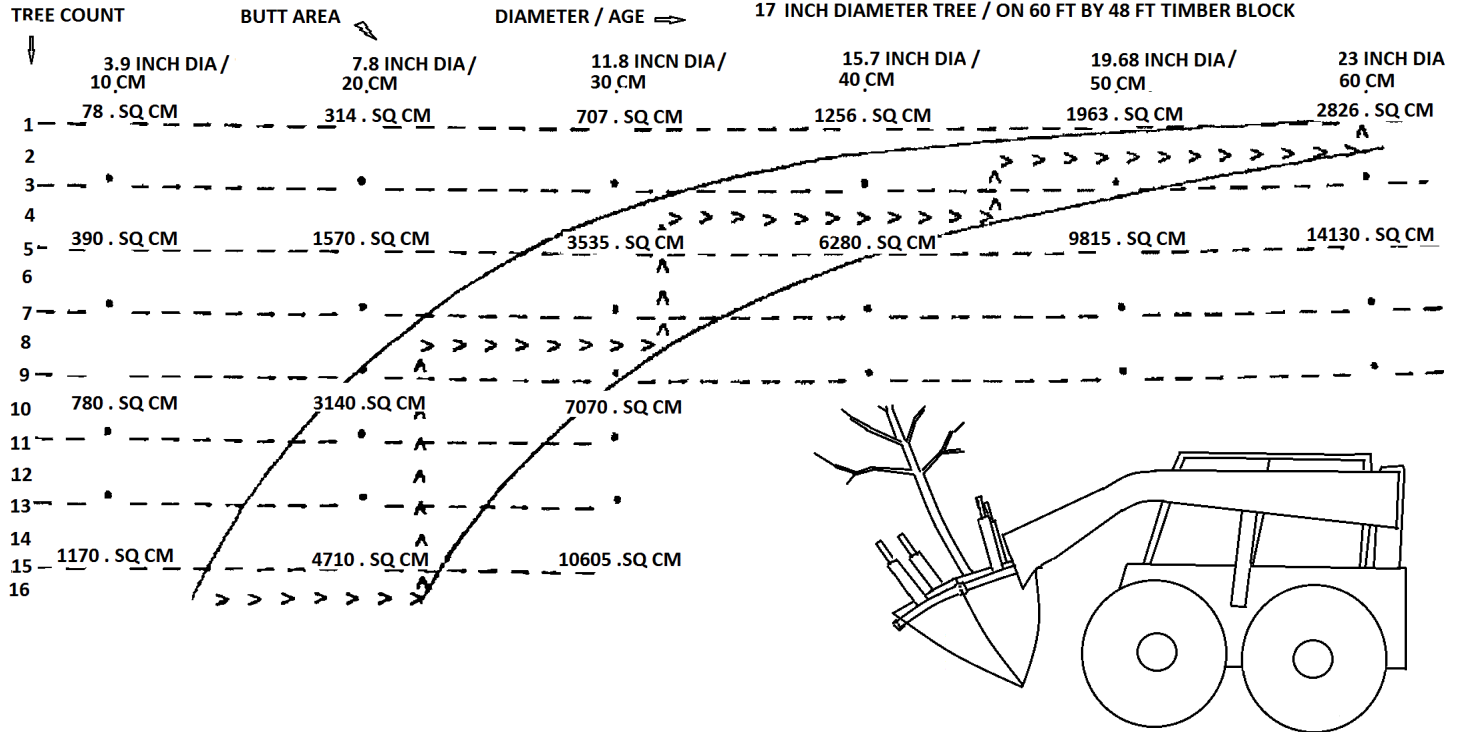


PERSIAN WALNUT ORCHARD - SPACING FOR THINNING TO 80 BY 60 / F.
1 TREE ON 4800 SQ FT



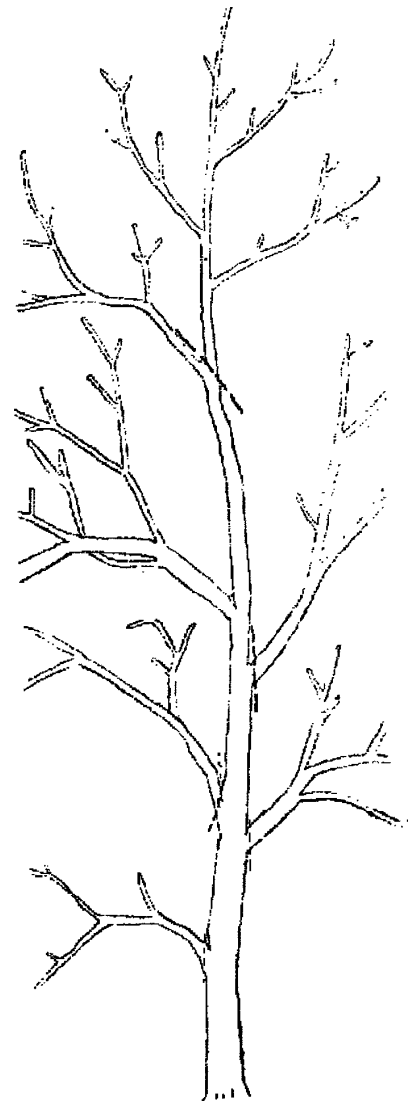
PERSIAN/BLACK WALNUT / PECAN / SHELLBARK HICKORY / HICAN / HEARTNUT HYBRID	BLOCK FT X FT	LAND AREA SQ FT	NUT TREE THIN DIAMETER,		TIMBER TREE THIN DIAMETER,	
			"START DENSITY" AT 30 SQ FT/AC LIMIT CM	"END DENSITY" AT 60 SQ FT/AC LIMIT INCH	"START DENSITY" AT 30 SQ FT/AC LIMIT CM	"END DENSITY" AT 60 SQ FT/AC LIMIT INCH
1ST THIN	20 X 15	300	15.7	6.2	22.1	8.7
2ND THIN	40 X 30	1200	31.2	12.3	44.2	17.4
3RD THIN	60 X 45	2700	47.0	18.5	66.3	26.1
4TH THIN	80 X 60	4800	55.4	21.8	88.4	34.8

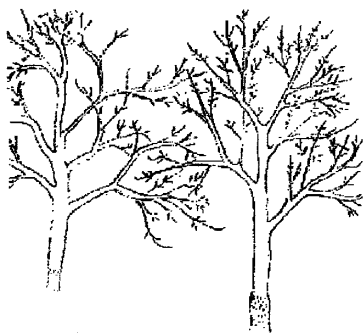
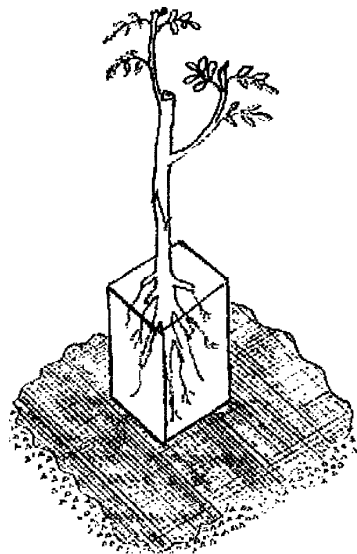
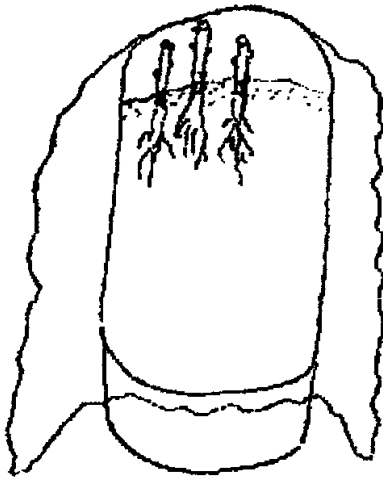
16 TREE PERSIAN WALNUT SPACE THINNED TO 1 (SPACE 80 FT BY 60 FT/TIME 10 YR TO 60 YR) IF GROWTH RATE IS 1 CM PER YEAR,
 12.5 INCH DIAMETER TREE / ON 60 FT BY 48 FT NUT BLOCK
 17 INCH DIAMETER TREE / ON 60 FT BY 48 FT TIMBER BLOCK



G. The thinning plot, drawn above, is constructed from the prior six spacing factors. Through the years the typical planting area, containing 16 trees, is cleared to one selected tree, 22 in./55 cm. diameter, 9 trees per acre.

H. Drastic pruning can maintain Persian production by allowing more light efficiency in the orchard while delaying the removal of trees. As Persian walnuts crowd and shade each other, energy storage for fruiting decreases, thereby reducing nut production. If drastic pruning is delayed, the stress of reduced light and soil injures the tree and its flowering. Nut production can be reduced by one quarter without the cause being noted. Prune trees to be removed, thereby releasing more productive and more permanent trees. While pruning, remember that un-shaded limbs which bend down, gather more light, and store more energy, producing more nuts, than ascending un-shaded limbs. Prune off entire limbs and sectors of trees that extend toward more permanent trees. Prune in July and August, thereby directing the tree's energy toward nut production, rather than dormant pruning, which would stimulate vegetative upward growth. Spray wounds with Avaunt insecticide, or equal, to prevent egg laying by the clear winged moths. These moths start borers in tree wounds during early summer.





IX. Propagating Persian walnuts is best done by bench grafting/ indoor grafting, or (to preserve something) by June budding. Both these methods control conditions well enough to demonstrate satisfactory results. Few other methods achieve the warm temperatures needed for walnut callusing. The conditions under which propagation is successful are daily temperatures around 75°F/24°C with high humidity, overcast, ground continually drying, and grafting materials previously treated with copper bactericides against bacterial blight. Because these conditions are most easily achieved in late spring and early summer, June greenwood budding is the most successful method of outdoor propagation. Indoor bench grafting is even more successful because all the conditions are maintained artificially. Bench grafting is time consuming due to digging, potting and replanting. June budding is slow.

A. Reasons for using black walnut root stocks:

1. Black walnut seed and seedlings are commonly available and often free.
2. Black walnut seedlings are hardier than Persians; thus make fast growth which is retained: No south-west injury. No curculio.
3. Black walnut has a deeper root system, more resistant to drought, traffic, and temperature swing.
4. **No** incompatibility has been reported in Ontario, although noted in Ohio (a peach tree leaf curl virus problem trapped at the graft union of walnut). Under Lakes' Region conditions unions between black walnut root stocks and Persian grafts are usually permanent. In certain regions of California this combination usually fails due to peach leaf curl virus trapped at the union. This condition is aggravated by warm spells during the winter which start the black walnut into growth while the Persian top remains dormant (These are French Persians with delayed vegetation.)
5. Top working 10 to 17 feet/3 to 5 meters high on black walnuts may produce a more acceptable timber crop (better top is heartnut.)
6. Black walnut is not as susceptible to south-west winter injury as is Persian. This injury is caused by fluids drawn up the trunk by sun warmed tissue and frozen under the bark when the trunk is suddenly shaded on a bright, but very-cold day.

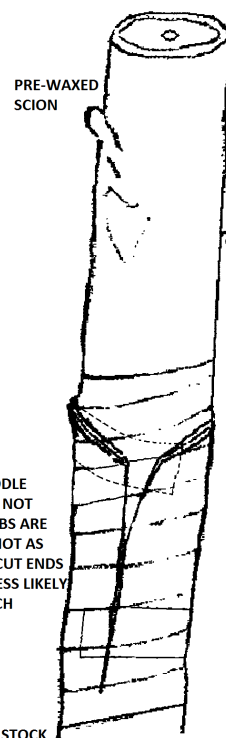
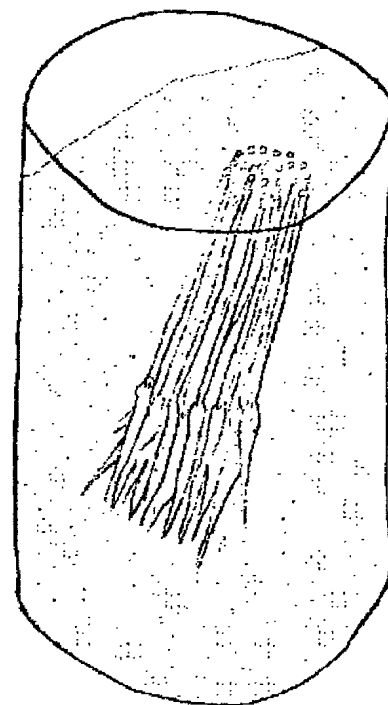
B. Reason for Persian walnut (or select hybrid heartnut) root stocks:

1. Persian root systems are easier to dig and transplant. Persians start the surface feeder roots early, and often lack the single massive tap root, and the very long side roots of black walnuts.
2. Persian tops often overgrow their heartnut bases. Structural problems will eventually overtake such trees.

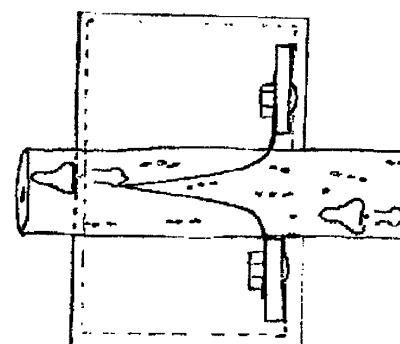
3. Persian on Persian reduces the possibility of stock influence. (Black walnut stocks may lead to truncation of jumbo Persian nuts.)
4. The Persian on Persian (or select hybrid heartnut) combination unite quickly, yielding more takes.

C. **Spring bench grafting:**

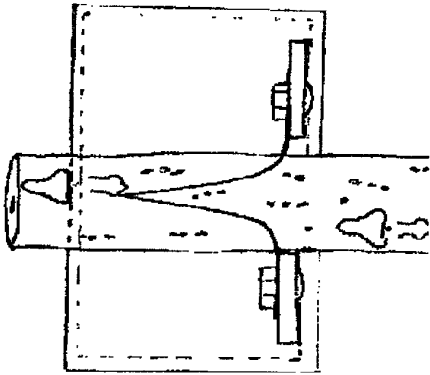
1. Material: Incubation chamber, root stocks and matched scions, sharp thin bladed knife, pruning shears, brush for painting-on wax, Teflon plumber's tape, Blenderm hospital tape/weather resistant electrical tape, grafting wax **not-smoking-hot** from crock pot, paper towels, sprayer of 2 Tablespoons/gal./2 T/4 l. hypochlorite bleach in water.
2. Before the winter becomes a test winter for Persians (0°F/-20°C), gather approximately 1/2 in./1.5 cm. diameter dormant scions, wood-filled terminal shoots of the current years growth (not water sprouts.) (Inspect to see few spots of brown freckled bark (no freckles is best, but this is often not possible, walnut blight already started, last season's spring frost may have caused walnut blight to explode, making this the season to buy scion wood, or June bud.) Pre-wax scions and store at, or just below freezing, in plastic bag wrapped in damp paper/peat moss...in another plastic bag in a paper bag.
3. Check for winter injury. Sacrifice a piece of scion wood by keeping it at humid, room temperature conditions for several days. Cutting into the wood should reveal green bark on white wood. Winter injury has a brown layer of dead cambium, in-between. In late March the brown layer may be checked, maybe fresh off the tree, or in a few days in the house. Brown specking, usually on a small sector of a scion's bark, is walnut blight, which will erupt during bench grafting.
4. Wax each scion for winter storage by brushing on a bit of paraffin; good enough at bagging because using grafting wax is too slow, messy, and not necessary at this busy time. Seal the cut ends. This generally takes two dabs because the first dab usually produces a bubble from the pith.
5. Store the scions at just below 32°F/0°C, and 100% humidity. Wrapping (as above, par. C. 2.) in air-tight plastic, and refrigerating, is sufficient for weeks to months of storage.
6. Dig root stocks in early April, and store them where they will remain moist, cold, but not freeze, and come out of dormancy slowly.
7. Modified cleft grafts are recommended here because it is speedy, and adequate strength of union, and the rapid callusing in the incubation chamber. Match root stock to scion. Cut, don't split, the stocks diagonally across the pith of the stem by rocking and forcing-in a thin sharp knife across, then smoothly turning down the stem. Cut into stock 1.5 in. /4 cm. Assuming the stocks were presprouted by planting 8 in peatmoss in a plastic pail, start the cut on one side of the stem, noticeably inside the wood (having severed the top with pruning shears at the top of the union), and end it over half way to the other side. If the stocks are bare root they can be cut with a



FIRST CUT OF THE SADDLE ACROSS THE STOCK IS NOT VERTICAL, OR THE NIBBS ARE BUILT TOO STRONG, NOT AS BENDABLE AS WHEN CUT ENDS 2/3 ACROSS STOCK, LESS LIKELY TO SPLIT STOCK, WHICH HINDERS CALLUSING.



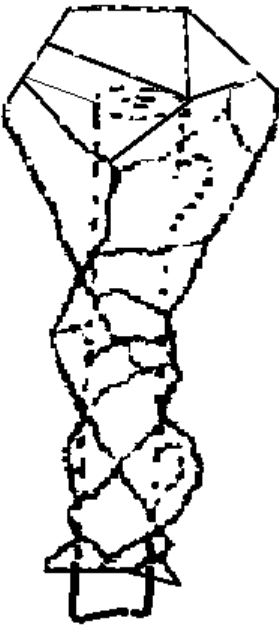
MACHINE CUT OF A CLEFT GRAFTING MACHINE



MACHINE CUT OF A CLEFT GRAFTING MACHINE

8. Choose a scion (with two leaf buds) which best matches the diameter of the stock (cambium to cambium). Held at 30°F/-1°C, the scion should be as fresh looking and as plump as when gathered. Cut the scion to a wedge shape (duplicate what you get from a wedge grafting machine.) Force the scion into the cut. Hope you don't hear a split because this is a stock failure; a large, loose cleft which needs too much first-aid. This is why you cut across the stock...to make it more flexible. Cut off split stocks lower, and try again. Stocks should be active/sprouting red, green, or white buds when you begin grafting.

9. Adjust the union so that cambium layer is touching cambium layer, even if a match is attained only on one side of the scion. Every grafting method requires that cambium layer be by cambium layer so that callus tissue which grows from both stock and scion at the cambium will meet and complete circulation through the union as fast as possible. Overall symmetry, or smooth bark to bark transition only looks best, grafts worst, for it unfortunately usually displaces cambiums from contacting.



10. Coat all exposed cuts on the stock and scion with grafting wax. Coat gaps between stock and scion (It is convenient to cap then wax a portion of the union with masking tape, not fill gaps.) Try to form a wax shell over these gaps to allow the tape, or wax covered gaps to be filled with callus tissue. A double turn of masking tape is often looped around the union to bridge gaps and speed waxing, plus strengthen the union. Indoors you can often rely on heat, wax, masking tape, and chlorine spray to replace Teflon and a turn of Blenderm clamping and sealing out-doors grafts, but only if the union receives no torque for two months until wood forms in the union.

11. Grafts done one at a time are placed into a tub (old chest freezer) of damp sawdust, and incubate at 75°F to 80°F/24°C to 30°C (usual night and day air temperatures) for several weeks. Thermostatically controlled heating cables, or space heater can control heat, but whatever the heat source the temperature at the heat source will dry out any hotter saw dust which has to be renewed with moistened saw dust. A steam humidifier under draped plastic film can provide humidity in a compartment, (often too wet when the sun goes down.) Spray daily with a water alternating with very weak hypochlorite spray, and with a stronger hypochlorite spray if any mold is seen. Some propagators use potted stocks in a humid greenhouse so that grafts can leaf out in humid, fully lighted conditions. They lay little tent/hats, folds of paper towel or linen on buds, and moisten/spray tent/hats with 2 T/gal. hypochlorite spray to humidify and treat buds until they are 2 in./5 cm. out. Check to see that the grafts are uniting. Light should keep graft wood surface-dry, or walnut blight could be severe. Remove sprouts from the stocks. In three weeks many Persians will be leafing out without any uniting of the unions. In about four weeks, after leaves are seen on the Persian shoots, the unions should be almost competent enough to reduce humidity, but continue to a full month if no mold is seen.



12. After a month incubation, walnut grafts should be carefully removed from the sawdust and potted. Remove all sprouts and buds appearing on the stocks. Move the containered grafts to a frost free shed where they can be exposed to some sunlight, but be protected from wind and cold night temperatures. Always keep the potting soil moist. A trailer eases moving out to shade in daytime, and in at night.

13. At the date for setting out tomato, pepper and melon plants, plant out the walnuts into tree shelters to direct the grafts upward.

D. June greenwood budding-T bud:

1. Material = Fast growing 1 in./2.5 cm. diameter stock, Persian terminal, sharp knife, rubber strips, roll of food storage film, masking tap, wire twist ties, Instaflex "joint support" taken as needed.

2. If the spring is dry, water the root stocks to saturation one week before grafting. The foreseeable weather should be dry and warm with light frosts at the time of budding.

3. Gather terminal branch-lets containing leaf buds. Long, fast growing terminals usually contain leaf buds which look like tiny cabbages. Short terminals usually produce male flower buds at leaf junctions, which look like tiny pine cones. Grafting male flower buds will do no good, starve any graft. Store the terminals in white plastic bags in cool shade. Spray a little house and garden bug killer in the bag to kill pests.

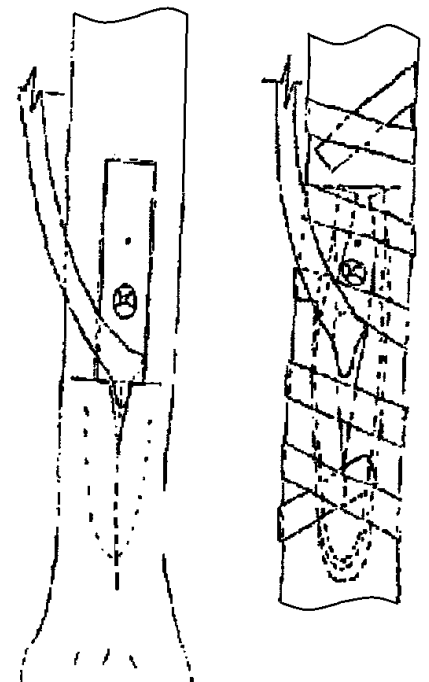
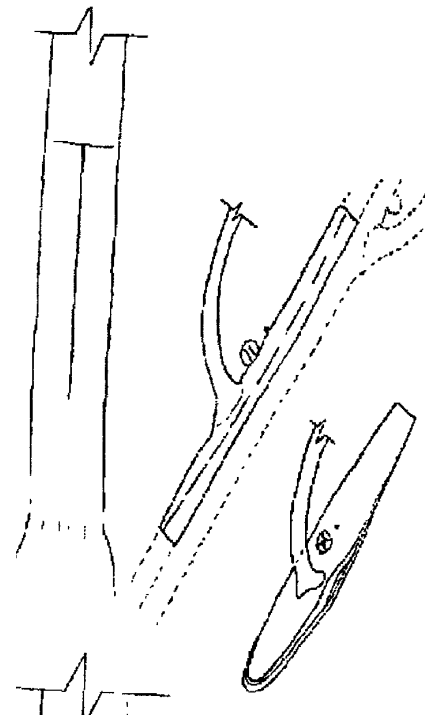
4. Protect cambium. Avoid direct sun, noonish heat, sweat, hand oil, and wind.

5. Slit the bark of the root stock 1 ft./30 cm. above the ground in a "T" shape. Approximately, the hat is 5/8 in./1.5 cm. and the T's stem is 1.5 in./4 cm. The slit depth is to the cambium, where the wood resists the knife's penetration.

6. Lift one flap on the T with the point of the knife to discover if the bark is slipping. If the flap tears, refusing to lift, not exposing the glistening layer of cambium cells on the white wood, the bark is not slipping or peeling, and will not callus properly. Go to another stock.

7. Remove the bud by splitting the terminal and severing-off the bud by cutting-in 1 in./3 cm. above to below the bud. Hold onto the bud shield by grasping the base of the leaf stalk. Slice off layers of wood and green gelatinous pith from behind the bud. At the final slice the knife is breaking the surface layer of bark 1/4 in./5 cm. aside the bud and 1 in./3 cm. below it, producing a smooth back-surface which retains gelatinous pith behind the bud and an all-wood tongue 3 cm. below it.

8. Insert the bud shield under the bark of the stock, using the base of the leaf stalk as a handle. Start it in by lifting the bark with the knife point. Shove the bud shield .5 cm. below the hat of the T to seat it in its final position. The bud shield is below the bark of the stock on all sides except at the top. Cut the shield into place, to fit with no gap, by cutting to the hat through the shield. Callus tissue will build from where the cambium is least disturbed, typically, the top, and the very bottom where the bud shield has raised bark from cambium by being pressed-in, no direct sun hitting cambium.



9. Bind the bark to the bud firmly with a rubber budding strip under slight tension.

10. Cut the leaf stem so that it will retain four leaflets. Bend up the leaf to embrace the stock where it can be bound with another rubber tie.

11. Cover approximately 8 in./20 cm. of the stock, centered on the bud shield, with one panel of food storage film, the kind that sticks to itself. Circle the stock with three or more layers of the film. Seal the top end of the film by stretching tight and taping. In winding the film, leave a 1 in. to 1.5 in./2 cm. to 4 cm. leaf arch between the leaf stalk and the stock just above the bud. The film at its bottom end is pressed against the stock and fastened with a twist tie. This vapor barrier must not be a perfect seal. It must exit water vapor slowly at the base and around the turns by the bud. Spray paint a sun shade where full sun strikes the film.

12. Approximately 18 days after budding, unwrap the film. Remove the leaf parts that will release with slight bending. If the bud is alive and callusing in, cut off the top of the stock 4 in./10 cm. above the bud. Re-secure the film by wrapping it loosely and pressing it tight above and below the bud. Twist tie the bottom.

13. Four weeks after budding remove the film, and any leaf stalk that remains. Cut the stocks containing late-to-callus-in buds. Remove sprouts generated from root stocks, checking at two week intervals.

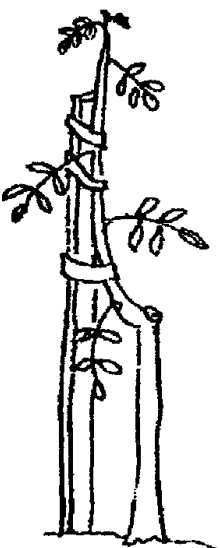
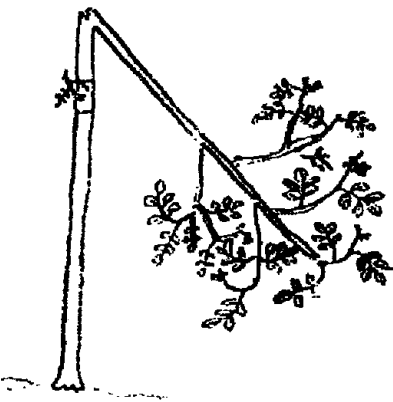
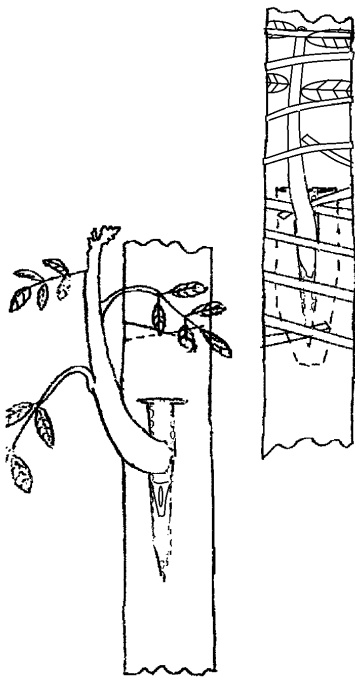
14. In August cut the stocks on a slant behind the bud. Until this stub was cut it could be used as a prop to support the bud's growth. Now you should bind the shoot to a stake to prevent wind from tearing it off.

15. Buds which heal-in without flushing a shoot, hardly ever survive the winter. Un-flushed buds are winter killed, if located inland, and the winter is harsh.

X. Persian walnut varieties:

1. Hansen is a nut discovered in Ohio of German origin which is hardy along the Lake shore (or house-protected away from the Lake). The nuts are small, 1.2 in./3 cm. diameter. The shell is very thin, 60% kernel. The kernel is very sweet at drop time in September because the thin shell and small size allows the nut to dry and cure on the tree. The tree is nearly a dwarf and needs feeding to maintain its growth. Hansen has high nut production, and often sets a crop after primary buds are frosted because it carries flowers in all its side buds, many of which remain dormant until frost removes the buds that vegetated. Metcalfe is Hansen's Carpathian twin except it does not have as much lateral bloom. Both are only hardy to a mile from the Great Lake shore. Both suffer frost, which calls for much walnut blight spray.

2. Bauer 2 is a hardy Persian from near Mitchell, Ontario. Although away from the Lake, it rarely misses a crop. Production and quality is very good. The nuts sometimes get hung up in the hulls by a late September freeze. Bauer 2 is a medium size nut, more than twice the size of Hansen. Typical of hardier trees it has medium shell thickness; yet, two nuts squeezed together in a fist will crack. It suffers from walnut blight.



3. Coble Jumbo is a nut from near Chambersburg, Pennsylvania which has brought us jumbo size, nearly 8 cm. long, and fair resistance to the bacterial blight of walnuts. It has excellent flavor like Clarke Jumbo. It ripens in September, earlier than Clarke, is better filled, and being riper it is easier to dry without molding. Its hardiness has not been tested away from the lake shore, but its acceptance in Pennsylvania shows its frost hardiness. Frost hardiness is often more of an advantage than hardiness toward deep winter cold because a site can be chosen to moderate cold (as next to a house, up a ridge).

4. Broadview and Young's B1 are large Persians with hardiness and good quality. In contests B1 has consistently scored in the top 2%. Broadview is Russian with late bloom. Both have too much walnut blight in Persian orchards.

5. Papple from Brantford, Ontario, Combe, from Utah, Lake from Illinois, I.S.U. 73H24 from Hungary by way of Iowa, Harrison from Pennsylvania are large egg size Persians which are rated hardy away from the Lakes, and blight resistant in Persian orchards. Ernie Grimo finds they drop as clean nuts with a minimum of copper sprays. This likely means they seldom frost injure because frost injured leaves initiate severe blight. Until we find a good shield against walnut blight we look up to these, and have started testing/breeding orchards from their seed near Trumansburg, New York.

6. Sylvania from Dr. Loy Shreve collections in and near Romania appear more blight resisting, but is new to us. Another selection, Shreve S3 (thick shell/very late vegetating,) may get most of its good resistance from being very late to leaf, whereas Sylvania may be the only blight resisting walnut that does suffer frost injury. Shreve's breeding at Texas A & M is discontinued due to the finding that Persians are not cropping due to late frost. California work does not put value in late leafing, seeing late leafing as mechanical blight resistance linked with a late ripening defect. Because Persians do **not** frost protect swelling buds, unlike heartnuts and pecans, we find evaluating Persian frost and BB resistance linked, poor, and difficult to evaluate.

XI. Projects with Persian walnuts:

A. Transfer frost resistance from Canoka heartnut (best frost resistance) into Persian walnut after finding where these genes are hiding. The hope is that the packet of these genes is handy to transfer, then make the right sugars for bud swell, and flushing leaf de-icing. Think genetic engineering, and not breeding. These species are too far apart for current breeding, though first generation breeding could reveal the frost-resisting-packet location.

B. Grow out the Dr. Loy Shreve selections, and others, which have bacterial blight resistance. The blight resistance of Sylvania and the frost resistance of Lake should be crossed and backcrossed.

C. Grow out Chinese selections which have side bearing.

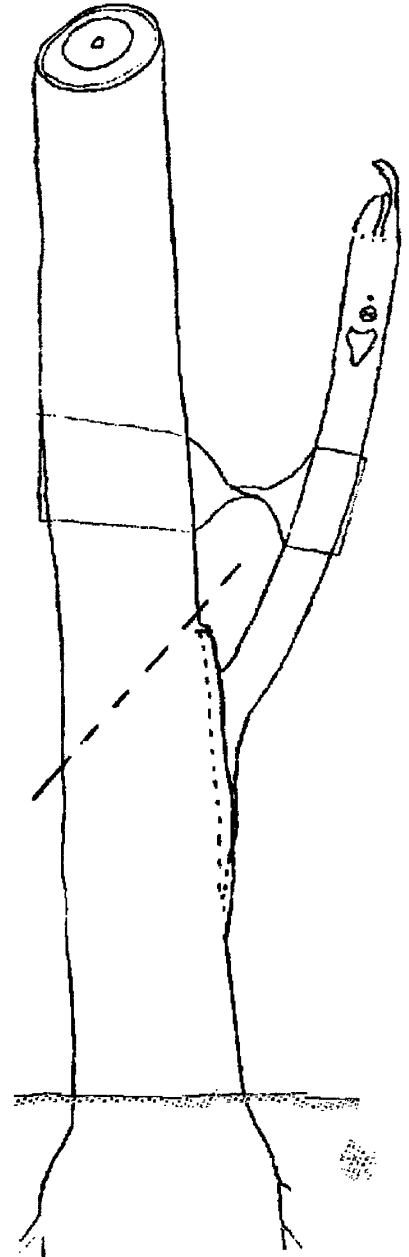
D. Survey for Persians that produce in test years when harsh weather eliminates production on most trees. What do the north islands of Japan hold.

E. Plant and grow out jumbo Persians to verify George Corsan's view that jumbos are hardier, though they need fast drying, or go moldy.

E. Just a foot note...we have spent years gathering and testing Persian walnuts to find that most had out sanding qualities which were mainly the workings of the site they were growing in. Many were from small plantings with an

outstanding tree near a house or barn, or on a hill, or

near the Lake.



HICKORY

PECAN (*Carya illinoensis*)

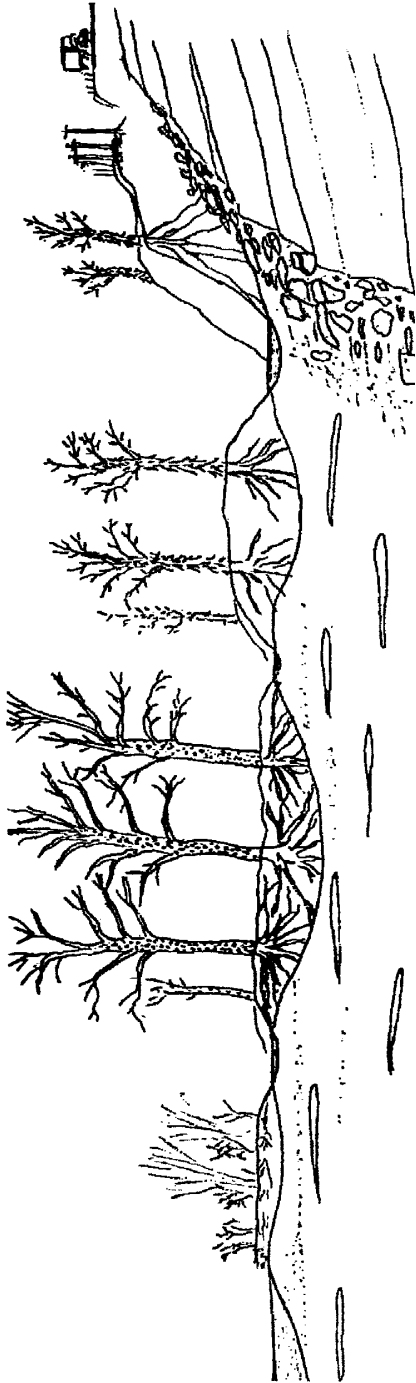
SHELLBARK HICKORY (*Carya laciniosa*)

SHAGBARK HICKORY (*Carya ovata*)

BITTERNUT HICKORY (*Carya cordiformis*)

HICAN (*C. illinoensis* x *C. laciniosa*, or *C. illinoensis* x *C. ovata*)

BITCAN (*C. illinoensis* x *C. cordiformis*)



I. Shagbark hickory is the sweet, white, round nut, large-gum-ball sized, familiar to most Southern Ontarians. Bitternut hickory is more widespread, but only food for squirrels due to its astringent kernel. Ontario shellbarks have 1 to 2 in./3 to 5 cm. diameter nuts, which are grey with tan veining. The bark of mature bitternuts and young shellbarks and shagbarks is like ash, but more polished and closely knurled. Mature 6 in./15 cm. shagbarks and shellbarks have identical bark which plates off in vertical 4 in./10 cm. wide strips which are yards/meters long. Kingnuts are shellbarks which grow large nuts the size of small matchboxes. Shellbarks grow native along the Niagara River to down the Illinois River, and up and down the Ohio and Mississippi. Ontario shellbarks are similar. Although smaller, Ontario kernels compare favorably due to thinner nut shells. To crack out whole half kernels find flat and smooth shell varieties because this smoothness reflects into the nut. Typically, shagbarks, shellbarks and hicans have a mildly maple, nutty flavor. Pecan is more bland like red hickory, but a sweeter, more melting kernel. Pecan is cooked to bond with spice in many recipes. The bits of bran which cling to the grooves of pecan kernels are rich in antioxidants used to keep nuts from going rancid, and helps cleanse free radicles from body tissue.

A. Pecans, then shellbarks and finally shagbarks grow on low to high banks, respectively, along the Mississippi and other great rivers. This succession is seldom violated. Bitternuts can be anywhere, and far north. Seeing how nature grows these nuts, offers insight on how we should grow them. Pecan is on low banks of sand and silty clay, between sloughs, 5 ft./1.5 m. above low water (meters above the low water of drought, but under the level of most floods either of which can kill pecan if they last long enough, as is happening with current diking.) Shellbark is meters higher on banks of sticky clay, at the level of fall floods. Shagbark is on the high bank where roads are built. Hicans are seldom encountered, but if discovered, pecans and shellbarks are nearby. Bitternut favors pecan sites and often hybridizes with pecan. Bitcan seems an appropriate name for this hybrid due to poor flavor, nut shell structure, and storage ability (Abbott's Bitcans are the sweet exceptions, except for degrading quickly as heat turns the nut pellicle red.) Some Bitcans appear to be pecans, except they have astringent kernels.

B. Although pecan has its own chapter, it appears here again because it is central to the understanding of hickory. Pecan is a hickory; the nut tree with the healthiest bark, the least-conservative-of-water hickory (enjoying the mixing oxygenated river water with brackish swamp water), the most commercial hickory. The theory is that pecan evolved at the edge of brackish water to be able to ripen late,

later than any other northern nut. What other nut in the world can change its kernel from goo to whole kernel in a week like Lucas pecan? Due to excess water pecan keeps growing (growing succulently, keeping pests in check) through the entire growing season (turning leaves from dark green to yellow after the light fall frosts, mid-October.) Genetic pest control of scab, anthracnose, casebearer, weevil (hickory curculio's grub), twig girdler, aphid, leaf hopper, spittlebug, jay, crow, and squirrel evolved with the retention of late season growth, annual cropping, dropping nuts during and after light frosts.

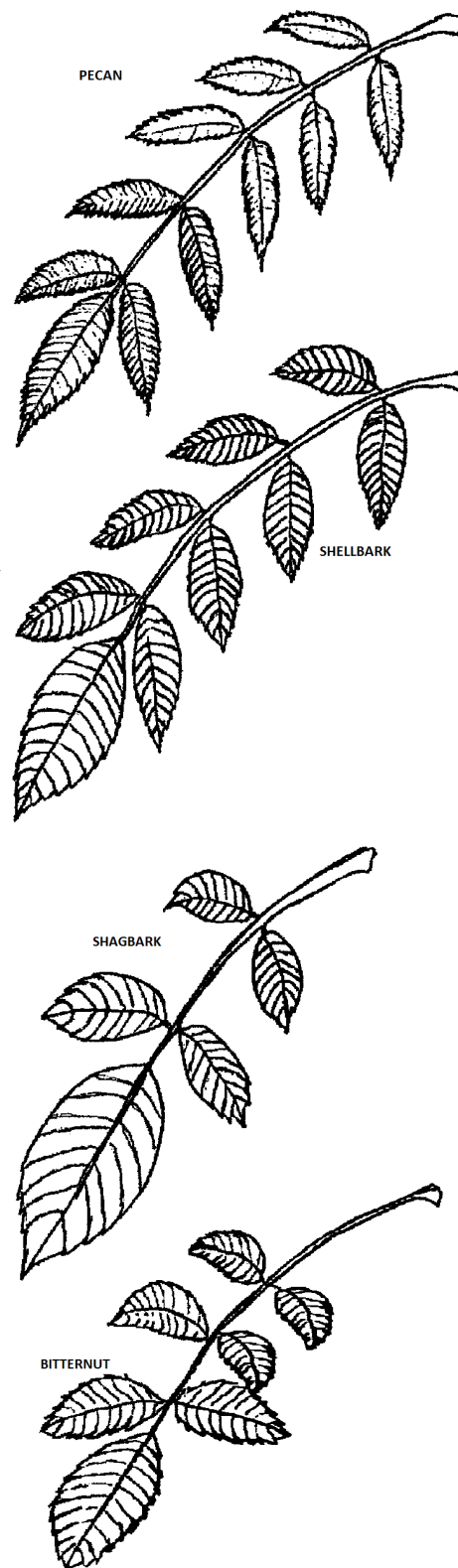
C. Shellbark hickory grows on the river flats on higher, more clayey banks than pecan. Nearby sloughs are more brackish and dry by mid season. Fall floods reach both shellbark and pecan. While pecan nuts often float away to lodge in swamp grass, shellbark nuts sink and roll along the bottom to lodge in tangles of brush and logs. Some of the nuts are distributed by crows and squirrels, but the majority of nuts growing on flood plains were distributed and planted by flood.

1. Shellbark hickory, like black walnut, is conservative about water, and rushes to complete the season before drought. Nuts are thick hulled and thick shelled. Walnuts, shellbarks and shagbarks from the Ohio Valley, St. Louis, Mo., and Tennessee will ripen in Ontario. Not pecans. For pecans to ripen in Ontario they have to originate where the growing season is as short as Ontario's. We lack mid continent sun and early spring. We need the earliest of the Iowa pecans above Clinton, Iowa on the Mississippi.

D. Walnuts, and especially shagbarks, and shellbarks defend against disease, insects and predators by quickly hardening shoots, foliage, and nuts, and by intermittent cropping. If abundant water washes away hickory's ability hold fast the early hardening leaves, shoots and buds, their renewed spurt of growth is decimated by leaf hoppers, aphids, and galls (usually a yellow aphid inside the gall). They lack the defenses of pecan.

E. Shagbark hickory grows on the high bank, or inland where ground is clayey, and at the edge of silty sand at temporary wetlands. When water is abundant, usually in spring, it is semi-oxygenated and flowing near to shagbarks. At a hickory bush (native stand) water recedes deep into the ground by mid season. The spike roots of hickory follow the water table and dish it down by pumping out springtime water. Hickory roots are tap roots unlike the deep spreading roots of tree hazel, and spreading roots of chestnut, and walnut. These three have deep root health provided to them by a deep water table, and flowing oxygenated water. Chestnuts over-all chestnut health depends on long surface-feeding roots and rain. Many of the large surviving American chestnuts have flowing springs 6 ft./2 m. below, but within reach of major roots.

F. Shellbark hickory has commercial qualities. The whole tree is healthier, and leaf is larger, glossier, with more leaflets than the five of shagbark, and much faster growing, larger, more spreading, and ornamental than shagbark (Dooley's Learherleaf shellbark is very ornamental.) Shellbarks grow, and fill nuts late in the season, but before hican and pecan. Doug Campbell's CES-24 shellbark selection is a hybrid unique in smaller, thinner nut size, and a larger kernel size than most shellbarks. We fulfill transplanting difficulties by trickle watering, and frequent broadcasting fertilizer sustain growth. Doghouse is a similar hybrid from Pennsylvania with thinner nut shell, and kernel more like shagbark with great flavor and cracking.



II. Storage and planting of hickory nuts:

A. Collect nuts as they ripen through early October. Crack some nuts at gathering to check kernel fill, shell structure and weevil damage. You should find that nuts which are smooth and flat on the outside, are also the easiest to crack and separate, reflecting a smooth, flat structure on the inside. Mid-west nuts with weevil holes are more likely to be in step with a mid-New York climate than their cousins with few weevils. Hulls which refuse to pop off are usually stuck on empty nuts. If there are many stuck hulls, collect nut to check again after a week of storage. If a squirrel gnawed the stem off a nut, it is a good nut. A nut with its stem sloughed off is a blank nut. Shellbark hulls, shells, and wood are used to smoke meats cooked with charcoal; heating these in an iron skillet produces a rich hickory smoke, and you do not need much smoke.

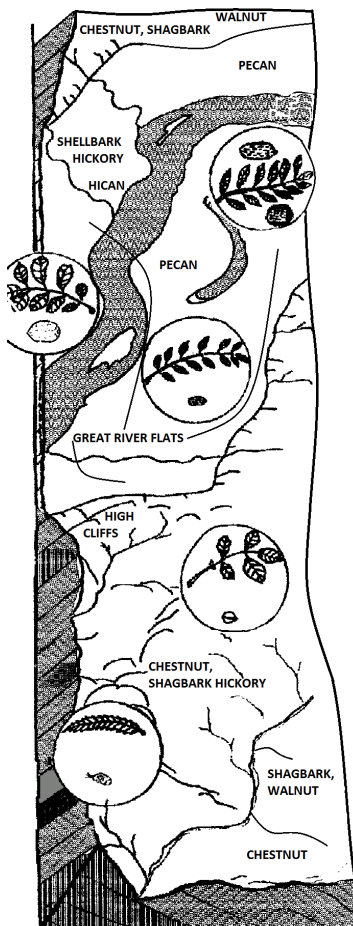
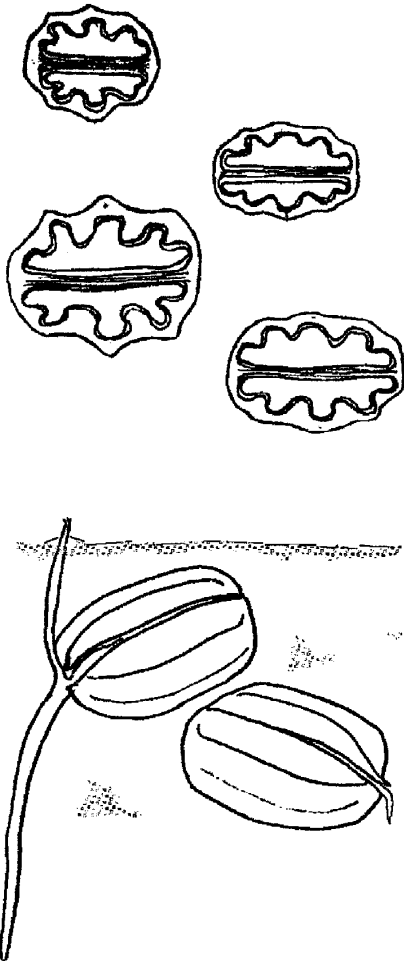
B. Storage of nuts has to be cool, and airy, so that nuts give up water without becoming surface damp and moldy. Piles of nuts mold unless refrigerated near freezing, packed in dry peat moss in cool storage, bathed in rain, or stratified in cool sandy soil. This is not quite true because I have found piles of nuts piled up and guarded by red squirrels that last into winter with no mold, probably due to fresh cold rain. Our nuts for eating are dried longer than nuts for planting. Seed nuts need not be dried, or even hulled, except to prevent mold until outside temperatures cool, and fall planting, or stratifying is begun. A grey squirrel hulls, and only noses nuts into the surface of the soil to store and germinate them (easy store, early germinate, easy find, easy feed to the pups.)

1. Stratify nuts in plastic bags with damp peat moss under root cellar conditions through winter. Alternatively, bag the nuts in wire screening, and bury the bag in a mound in the garden, remembering to remove and plant before trees leaves size for shade in spring. Ideally, the nuts are moist and functioning, measuring time and temperature, as does the parent tree, to grow out after the soil warms in the spring.

2. To fall plant, lay nuts on their flat side and cover with an inch/3 cm. of dark garden soil. Mark rows with sticks. Usually, weeds are up in May, and hickories in June, allowing 4 in./8 cm. new grass and weed growth and spraying of Roundup + simazine herbicide in late May. Squirrels and crows eliminate many nuts emerging out of clean ground. Protection with two layers of orange diamond plastic construction fence guards nuts, especially if hawks keep watch for mice/squirrels from lookout trees. Spread orchard bait to kill mice under snow.

3. To spring plant, sow under 2 in./5 cm. of soil. Some of the nuts from stratification may be sprouted. These sprouts are roots and must be planted pointing root down. If stratified in peat moss, and none have germinated due to dryness, soak the nuts in cool water for several days, changing the nuts to fresh water daily. Agway and Co-op stores sell corn treated with zinc phosphide as an orchard bait. It may be necessary to bait the planting bed. If the nuts are planted in May rather than April, delay spraying, and direct herbicide away from shoots of first-up nuts.

C. Match the seed source to your local growing conditions. Length of season, extremes of temperature, type of soil, amount of rain, and the amount of summer heat and sun have kept us "close to home" while gathering acclimated nuts. For hickory, this means going east and west for seed. Southern seed, brought north, should descend 500 ft./150 m. in elevation for each 100 mi./160 km. change in latitude to be in step with northern climate. Early ripening selections also travel north, but usually slip to a week later ripening for each 100 mi./160 km. movement north. Western selections lose a month of summer heat/sun moving mid-Indiana to mid-NY, or north of Lake Erie.



Growers are often too quick to select for a good nut, and not for our cool climate, which has brought in many southern pecans, which are not hardy, and do not ripen. Glossy catalogs would have us buy "hardy northern pecans", but these are for Illinois/Ohio/Lancaster, PA.

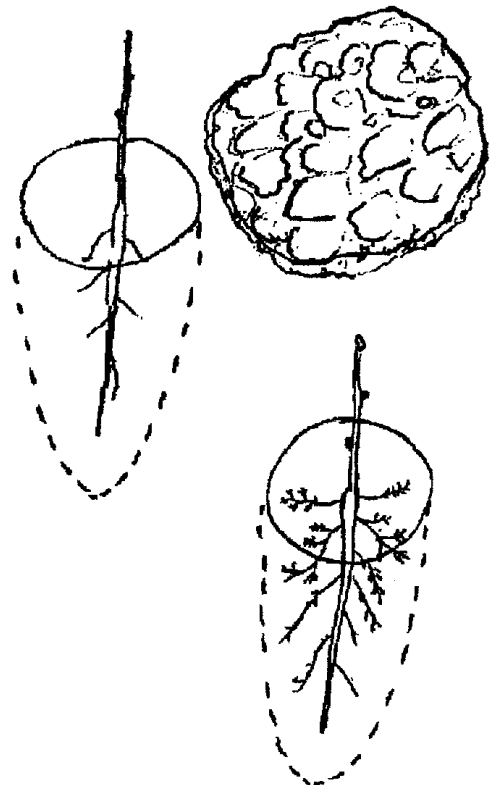
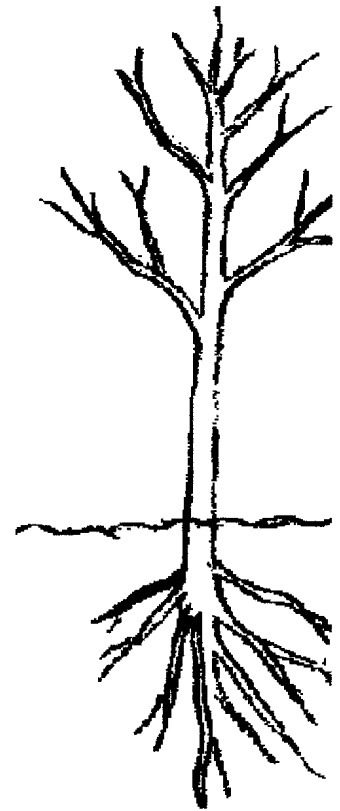
D. Sites chosen for hickory tend toward moist areas. Native sites of pecan, shellbark, and even shagbark are black soil locations which rim swamps. The trees stand in water temporarily during flash flood, or spring run off. Ideally, fresh flowing water is a few meters underground. Upland sides can be improved for hickory by scooping out sink holes in the soil at rivulets above the trees to catch water and deliver it underground. Near swamps the hickories pump the water down and, hopefully, it will wash in again with summer rains. Ontario hickory sites are the white oak sites, above elm-ash swamps, and below red oak, white pine ridges. Commercial sites would need land leveling for uniform irrigation.

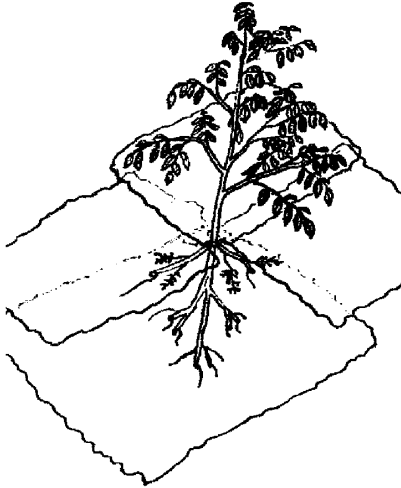
III. Transplanting hickory is strenuous. The single spike root of a hickory was meant to drive down until confined by rock or water table. Top growth is weak until the root can pump generous amounts of water. Two or three year old seedling transplants take hold mainly because the top of their root is in sun warmed surface soil. A plastic film mulch and other measures which warm and moisten the soil are required for large or grafted trees. Recovery is slow.

A. Clear plastic mulch plus weed killer should replace black plastic for tree mulch. The soil warms faster and deeper. A herbicide like simazine is needed to remove weeds. The film should rest on the soil and confine moisture, strategically seeping-in water.

B. Transplanting and maintaining hickories:

1. Dig or buy hickories with roots approximately 3/4 in./1.5 cm. diameter and 2ft./0.5 m. long. These are usually 2 or 3 year old trees 3. ft./1 m. tall overall.





2. Once grass has grown 6 in./15 cm. spray Roundup + simazine in a 7 ft./2 m. spot. a half day ahead of digging. Ideally, the hole is dug and refilled, mixing in 2 lb./1 kg. of bone meal and 2 lb./1 kg. 14-14-14 granular fertilizer the fall ahead of planting. If dug the current spring only mix in only bone meal because granular fertilizer will burn tree roots, or substitute Osmocote granular which is sulfur coated to protect roots, and slow its release/dissolving.

3. Dig the planting hole broader and deeper than the root system to be planted, though a six inch auger satisfies most hickory and pecan planting.

4. Mix a cup of bone meal into the replant soil.

5. If root system is older, and cultured by root pruning, it may have side roots. If so, spread this root system and trim injured roots. Thick roots, above 3/8 in./1 cm diameter, which have torn ends should be pruned to smooth, wedge ends. While planting keep the roots out of direct sun, and do not allow them to dry off.

6. Place the root in the hole so that the root crown is 4 cm. above the original ground surface. Hickory will refuse to leaf out if the root is injured by exposure to direct sun, or drying.

7. Filter in the planting soil while spreading the root system. (Hickory and pecan will have few side roots, thus can be augered-in in 6 in./15 cm. diameter post holes.) Remove weed roots and clippings from the replant soil.

8. Tug on the stem while tamping the soil to consolidate the soil and remove air pockets. Rod the soil with a stick or shovel handle to expel air.

9. Water to help consolidate the soil, but do not flood out the soil replacement and tamping until it is about complete.

10. Hill brought-in soil 6 in./15 cm., or more above the root crown. This mound will settle, and be gone in a year, so may need renewal over the root crown if a depression forms. Stake a tree tube shelter over the tree, tapping it into the ground a few centimeters so that mice do not enter. Cut down the shelter so it tops the hickory by 4 in./10 cm. for greenhouse protection of the first leaves only.



a. Alternatively, stake on a 5 in./13 cm. diameter tube of octagonal plastic garden fence, inserting the coil 2 in./4 cm. into the ground. This fence is insurance against rabbits, wood chucks, and deer rubbing. Peach trunk paint, white latex paint mixed with Thiram, is insurance against sun scald/southwest injury, and rodents.

b. Mulch with clear plastic film if you have it. Kill weeds. Remove the plastic film by summer. Soak the soil with warm water at weekly intervals through mid summer. Use 5 gal./20 l. plastic buckets to water deep to the roots.

11. Starting at planting broadcast 14-14-14 garden granular fertilizer 2 lb./1 kg. per inch/2 cm. of trunk diameter, broadcasting away from trunk, and past branches farther with each spreading. Renew fertilizer each two months, and through the next growing seasons. Renew the Roundup + simazine spray when weeds return. Simazine + Solicam weed killer which works in the cold is applied with the first frosts in the fall.

12. When weeds return the second year, hoe and spray with Roundup + simazine.

13. In future years maintain a 7 ft./2 m. spot of bare soil at each trunk by spraying Roundup + simazine.

14. Prune to remove dead, rubbing and malformed limbs. Plan ahead and remove limbs past the branch collar before they increase to 1 in./3 cm. diameter. Maintain a conical shaped tree with the longest limbs nearest the ground. Conical shape reduces shading in a tree with dense foliage. Conical shape helps protect the trunk and major crotches from southwest injury. CES-24 (like many hybrids) needs corrective pruning to remove limbs with narrow crotch angles.

15. Once nut production is underway, after about 12 years, expect to fertilize with 1000 lb./500 kg. of 12-12-12 fertilizer per acre per year, mainly spring applied. Supplements will have to be added per leaf analysis. Foliar sprays of zinc sulfate and urea are common for pecan. Leaf analysis is tricky due to the ability of leaves to concentrate the minerals tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding. Organic mulches keep soil active with flora and fauna, which free up bound minerals.

16. Begin removing trees as crowding occurs. For fruit start when 70% of the ground is shaded at noon, and end when less than 50% is shaded. Remove poor producers, stunted and diseased trees first. Pretty much 35 ft./10 m. spacing and intercropping is reasonable until trees are 35 ft./10 m. high.

17. Before harvesting nuts, prepare the orchard by mulch mowing grass and debris.

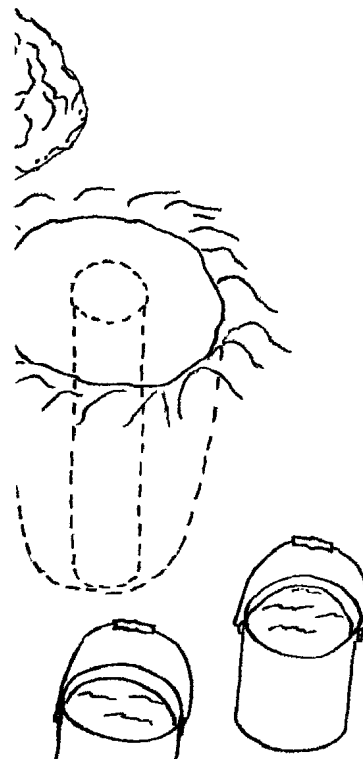
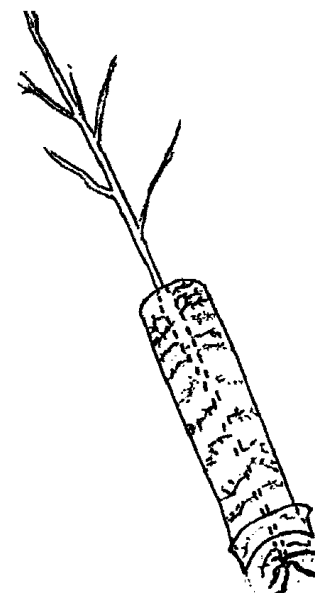
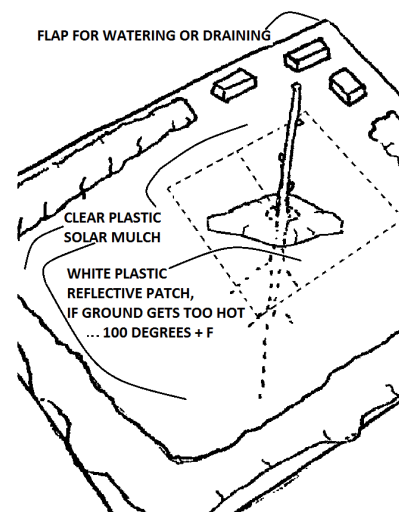
18. Pick up all nuts, then mulch mow all downed leaves, hulls and branchlets to eliminate habitat for pests and disease.

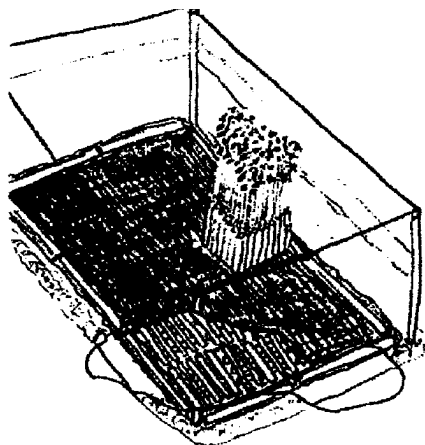
19. Aphids may be a problem, but can usually be controlled with turf management which provides grass as a good home for the aphids (and predators), better than the canopy. The canopy usually gets much attention from insect eating wasps during hot sunny days.

IV. Establishing hickories:

A. Start nuts where trees are desired. Plant extra. Eliminate misfits. Graft over poor producers, but only if they carry dark green leaves, and fast growth.

B. Transplant small trees which best fit to shallowly warmed spring soil, and recently fertilized (modified) surface conditions.





C. Shelter transplants in tree growth tube protectors, Tubex, or equal.

D. Use northern pecan on bottom land, even irrigated upland, or shellbark rootstocks for hardier survival and growth on upland.

E. Use solar mulch, or fabric.

F. Plant container grown grafted trees.

1. Containerized grafted pecans were sold by Wendell Greiner of Mulvane, Kansas. Survival and growth are excellent, with trees in full leaf and bearing nuts when planted. Establishment depends on getting enough water to the trees through the first season. Wendell buds pecan in the field, digs and pots after they have grown-out one year, and fortifies their root ball (cylinder) in a solar pen through two seasons.

2. Greiner's containers are meter long cylinders of black 6 mil./15 mm. plastic duct, 6 in./15 cm. diameter, cut to 4.6 ft./1.4 m. lengths with (12) 1/2 in. diameter side holes, but no bottom holes. Side holes are punched with a small piece of sharpened water pipe. An 6 in./15 cm. pigtail is tied at the bottom with polypropylene twine. Soilless growing mix is used to save weight, and hold extra water. Soilless growing mix is equal parts of sphagnum peat moss (or pine bark) to perlite (or vermiculite), 0.1 parts dolomitic lime finely ground, .05 parts 14-14-14 Osmocote, .05 parts calcium sulfate (gypsum), .0025 parts fritted trace elements. Ratio is by weight and assumes that the air dry mix weights 20 lb. per 25 gal./10 kg. per 100 L. Pro-Mix is a ready-made soilless potting medium to use as a substitute.

3. A solar pen is necessary to deliver the sun's heat to the containerized roots, speeding their recovery, and lateral growth. Covered with lath, it doubles as a winter lath house for cold wind protection. However, as a summer solar pen, there is an air space (pallets) between containers and the ground. In a winter lath house, the containers must sit on the ground to draw up heat to keep the roots from freezing. Sand may be needed for extra insulation around pots.

a. **Solar pen:**

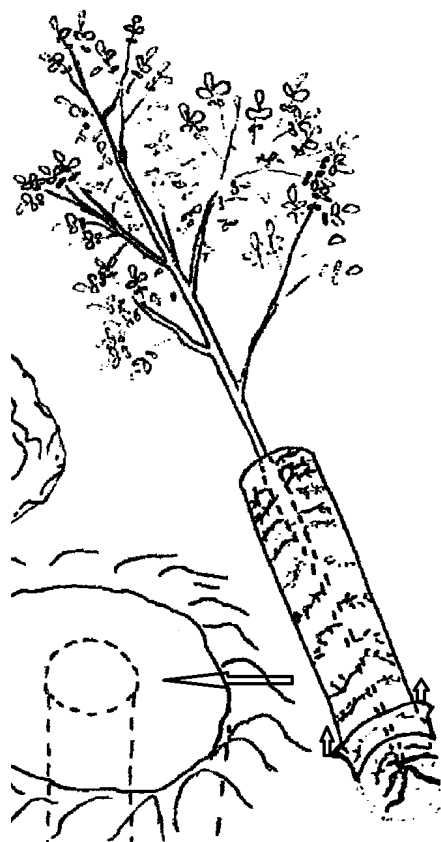
(1) Dig in poles as though to erect a board fence in the most sunny, non-windy location available; top rail at 6 ft./2 m.

(2) Cover the yard with discarded pallets.

(3) Cover the pallets with black plastic, staying seams and edges with boards. This floor is the heat trap, extending well beyond shaded areas and without top or side openings to chimney-off hot air. 50% of its areas should be covered with containers.

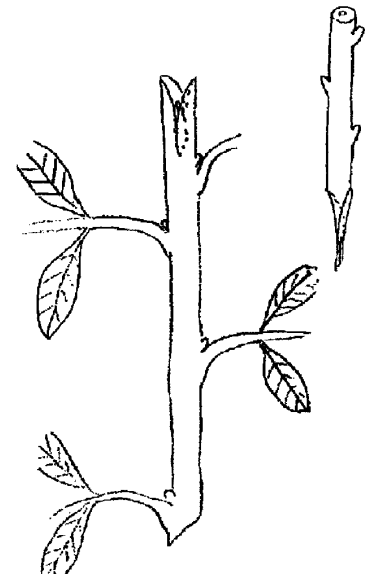
(4) 15 mm (6 mil) black plastic is draped over the fence, buried on the outside and covered with weights on the inside, carpeting on top.

(a) Plant out trees in fall, or take up pallets, and set containers on earth during winter. Drape old rugs over plastic during winter. Insulate pots, if the pots are open to freezing, with sand.



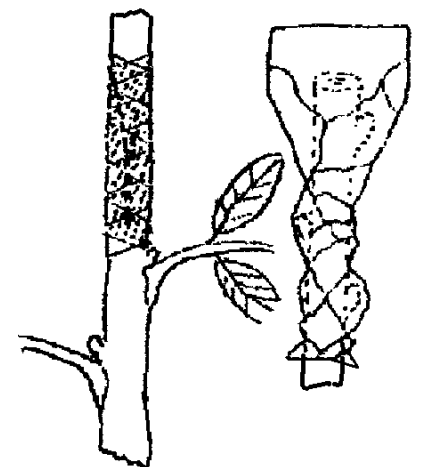
(5) Spray hickories with foliar fertilizer, insecticide and fungicide perhaps at weekly intervals, or when pale green or injured. Water the containers to saturation at weekly intervals, or when underweight.

(6) Root growth in the containers tries to descend but is blocked in a way that kills the root tip. If you untie the pigtail and observe the tip of the cut tap root it is seen to generate a star-cluster of roots. These are trapped as stubs in the folds of the pigtail. Otherwise, a single spike would extend to regenerate itself. Above, other cut roots are extending.



V. **Transplanting 1 year/3 ft./1 m. containered hickory:**

- A. Dig a meter deep hole wider than the container.
- B. Mix the replant soil with 2 lb./1 kg. of bone meal and/or 2 lb./1 kg. 14-14-14 Osmocote.
- C. Gauge the depth of the hole by measuring the containered tree up to the root crown. Root crown is to be 4 in./10 cm. above ground.
- D. After the hole is ready, lay the containered tree on its side and untie the pigtail. Fold the plastic tube up against the container wall to form a cuff. Start pulling the cuff up along the outside of the container.
- E. Set the container in the hole so the root crown is noticeably above the ground surface. Extend the cuff up as re-plant soil is replaced.
- F. Water the replant soil generously. Rod the soil to remove trapped air. Don't spare the water, and wilt the tree.
- G. Mound an irrigation dish with brought in soil above the root crown. Fill the dish with water to saturate the soil. Refill weekly, or however often it is necessary to keep the soil moist.

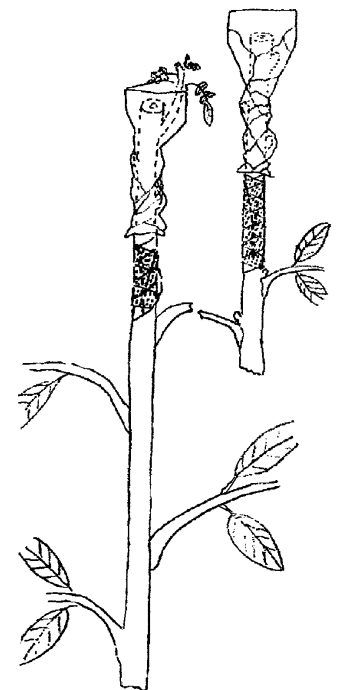


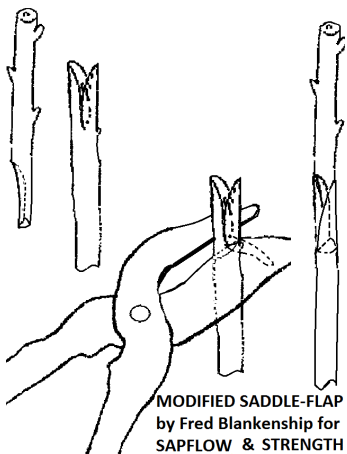
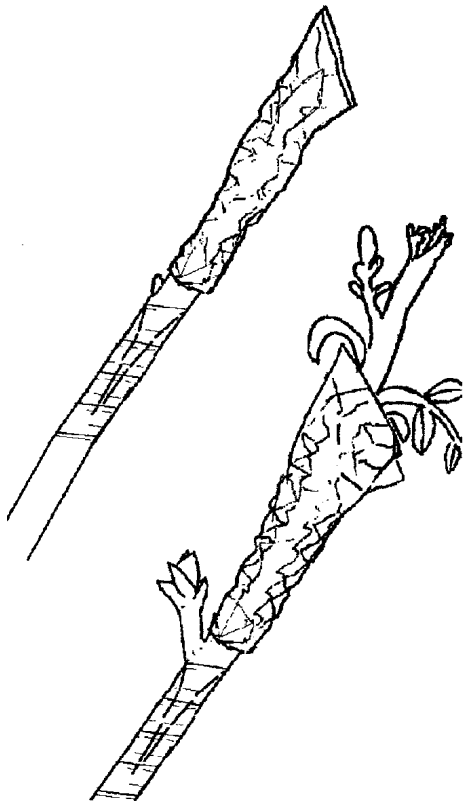
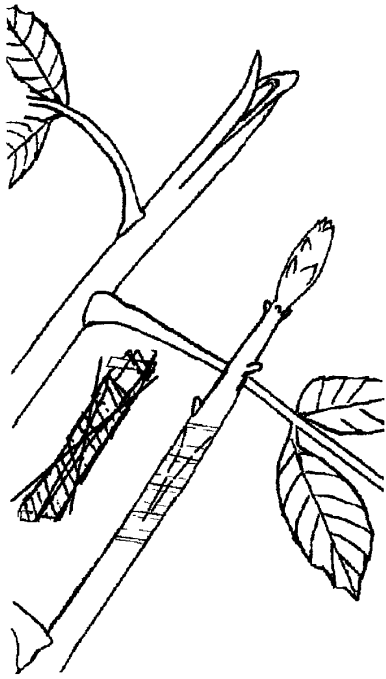
H. Hoe, lay plastic, fabric, or spray Roundup + simazine to control weeds. Remove the plastic by summer.

VI. **Dormant grafting hickory** is delayed until late frost/ tomato transplanting, May and early June, to coincide callusing with hot dry weather. Methods used on fruit, chestnut and filbert in late April and early May are impractical for high temperature callusing and bleeding-prone trees like walnut, pecan, hican, and hickory (unless chip budded). Stocks cut into slipping wood/bark easily results in excessive bleeding injury. However, into fourth week after grafting, turn on the water to force the buds on the grafted wood.

A. Advantages of grafting dormant hickory scions on greenwood terminal shoots:

1. Callusing and vigor are insured in green shoots which spring out to the 3/8 in./8 cm. diameter woody shoots needed. If the green tip diameter is too small, or too much the texture of celery, go farther down toward dormant wood. Hopefully, 2 to 5 leaves are left functioning on the greenwood shoot to feed the scion. These leaves duct-off excess water.
2. Expect the scion growth to be short, but stock vigor is retained for full growth the following season. Too much growth will need staking.
3. Dormant waxed scions only need an aluminum foil sheath, crimped for removal by unfolding buds, but dormant buds must be forced in the fourth week after grafting, by heavy watering of the soil.
4. The Blankenship method, half inverted saddle/half flap graft, should hasten callusing, and lessen bleeding. See illustration next page.





MODIFIED SADDLE-FLAP
by Fred Blankenship for
SAPFLOW & STRENGTH

B. Disadvantages of grafting dormant scions on greenwood:

1. Scion to stock match is limited to tip shoots, 3.8 in./1 cm. to 1.5 cm. diameter.
2. Pecans can be grafted later in the season than shagbarks or shellbark. Hickories bounce into growth and shut down by mid June unless abundantly watered. A week is typically the full season, window of opportune grafting after stocks bolt 10 in./25 cm.
3. Hickories are often afflicted by sucking insects even though only three weeks later than their terminals normally set bud.

C. Grafting dormant on greenwood:

1. Gather dormant terminals in early March. Wax by dipping cut ends and tips in melted paraffin, lightly brushing paraffin over side buds for temporary cold storage. When all scion wood is in, pre-wax scions by cutting to length, dipping in grafting wax, and are sealing in a bread wrapper which is wound with moist paper towels, and sealed in a second bread wrapper, then into a labeled, insulating paper bag. Store scions at freezing temperature, 32°F/0°C.
2. Begin grafting when terminal growth is at least 30 cm. long. Slice off terminal growth at the least diameter needed. If wood has begun to form, the union is good here. Without wood stiffening the stock, the celery-like stem usually withers from under the graft. Cut lower to find some stiffening wood. 2 to 5 leaves must be saved on the growing shoot to avoid bleeding, and maintain photosynthesis. If no wood is between the third and fourth leaf, delay grafting for a few days. If wood has formed to the tip of the shoot, the scion usually grows too weakly to survive. (Soak the scions for days, wax removed at base of scion to achieve some slipping when doing the half saddle/half flap graft.)
3. Join stock to scion with an inverted saddle graft. Cut the stock, drawing approximately square across the shoot, then down. Cut out a 3 cm. long cusp of new wood. Thus, a drawing cut, down and curving axially, and a piercing cut, axial-upward and curving to the edge, should remove the cusp.
4. Draw cut the scion to a wedge point.
5. Insert the scion in the stock and see that cut layers of bark and wood are opposite.
6. Wrap the union airtight, pulling the nibs of stock against scion using plumber's Teflon, and wrapping upward, seal in nibs and scion.
7. Clamp off the Teflon at nibs with two turns of Blendern.

Without this clamp of first aid film (or electrical tape) the stock, callusing and expanding from the base of the V upward to nibs, can pull, and unseal the Teflon. Think of the successful graft union wrap as a tiny, airless white greenhouse.

8. Form heavy aluminum baking foil over the scion, crimping it so that it will unfold as the scion leafs out.

9. In following seasons remove all growth near the graft to force growth through the graft. Brace the graft against wind, if rampantly growing.

VII. Shagbarks cropping in Ontario:

A. Yoder #1, Porter, Glover, Wilcox, Neilson, and the great seedlings of the hybrid, Burton are all large (especially in a moist season), thin shelled, and productive, though off years are common.

Weschcke, Campbell #26, Campbell #8, are all smaller, thin shelled and productive with off years.

B. Neilson is the early ripening and produces most often though it cracks and traps some kernel. Glover, and CES-8 shells are flat, white and very thin. Glover's leaves are a glistening dark green.

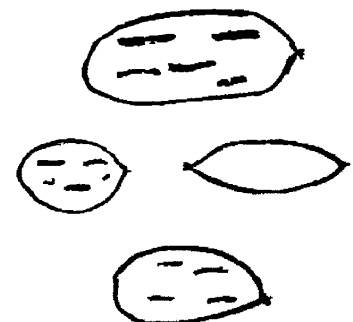
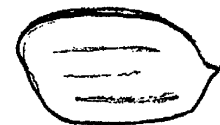
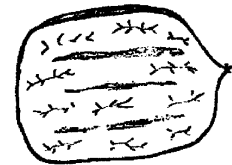
VIII. Shellbarks cropping in Ontario:

A. Fayette, , Keystone, Henry are medium sized shellbarks, productive, with off years. Doug Campbell's CES 24 is smaller, but mainly due to a thinner shell. Fayette, and CES 24 are the earliest ripening. Henry from Pennsylvania has been the most productive and easiest to extract. Campbell #24 (CES-24) from Sarnia, Ontario has the best shellbark flavor, and thinnest shellbark shell. Doghouse from Pennsylvania is a hybrid, but looks like a shagbark, and has great shellbark/shagbark taste.

IX. Pecans cropping in Ontario:

A. Deerstand, Snaps, PK Jumbo, Cornfield, Oaks, and Diken are Bellevue, Iowa selections that ripen early enough to dry before hard frost. These split hull, and dry enough, that their kernels survive frost, but have to be shaken down at hull split to survive birds, or very early frost. These selections are 2.8 cm. long. Their tree health indicates full adaptation in Niagara. Their nut size indicates a need for irrigation, and breeding. Abbott is a bitternut hican with similar ripening, and pecan flavor. Henke is a 3 to 4 cm. hican that ripens a week earlier than the earliest above pecans. It tastes like a shellbark hickory.

B. Campbell's NC-14, S-24, Colby, Fritz Flat, Lucas, PK Colby, Dejay, and Fisher are 3 cm. long nuts which just ripen in Niagara (ripen enough to germinate each year). They have been as high quality as typical of the mid West ripening, but that was in the hot long seasons of 1991, 2006, and 2010. Usually their nuts have to be shaken down, and taken to storage by time of frost, or their kernels suffer freeze injury when we have hard frost.



PECAN

I. Pecan (*Carya illinoensis*) may become a common nut throughout the low elevations of southern Ontario, and mid New York.

A. Northern pecans from the Mississippi flats of northern Illinois/ mid-Iowa are as hardy and early ripening as black walnuts. Often local pecan trees are misidentified as black walnuts. Named northern pecans like Deerstand and Snaps ripen near Buffalo, NY in late September/ early October, producing flavorful nuts. The northern pecans will ripen with chestnuts, but need variety selecting, suitable site, irrigation, nutrition, and shaking down.

B. Pecan trees tolerate flooding which would kill black walnuts. Pecan root systems are specially suited to growing on a flood plain. Immense pecan trees grow on compressible clay/silt and sand. The hundred pecans in the most northern grove on the Mississippi near Bellevue, Iowa seem to have no root crowns. They are buried by siltation. When planted as an upland tree pecan has a broad root crown like walnut or oak, and they benefit from the drainage away of cold air, and need irrigation in the high bank/high relief orchard.

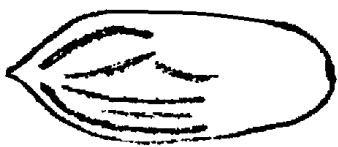
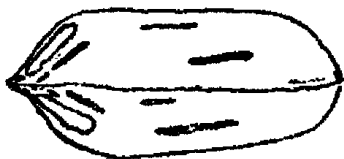
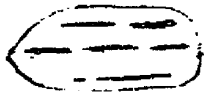
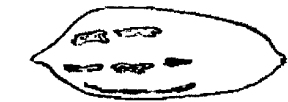
C. Pecan selections are typically more productive than walnut selections. Pecans have to be shaken down. Walnuts and chestnut come down with wind. Along the great rivers of the central U.S. native pecans enjoy constant water level fluctuation, which brings in aerated water, and rich clay/silt deposits that get stopped in vegetation and debris.

D. Comparing pecans and hickories with good kernel, pecans are much easier to shell due to their brittle, smooth shell structure. Crows seem to be the main evolutionary instrument for pecans. Brittle shell, smooth shell structure, easy to grasp elongated shape, bearing inside the canopy of the tree, all point to the crow which is noted for harvesting the best pecans. If you want to find the earliest, and best pecans, listen for crows feeding out of a large, dark green tree.

E. Pecans are harvested while the trees are growing to produce valuable timber. We had a 2 ft./60 cm. heavy wet October snow in Buffalo, and I realized pecan survive by major limbs breaking, not at the trunk, but half way out the limb. What is ruined rots away in 3 years. Pecans comes back, no problem. Pecan timber is often harvested after a hurricane, tornado, or ice storm ruins (appears to ruin) southern groves. This quickly builds an increasingly valuable log market, but scarcity ends it once damaged trees are removed.

F. Grass is often grazed under pecans due to their open shade, with deep root systems, on moist land. However, haying would be less harmful than the injurious compacting by hoofed animals. Also, harvesting the ground cover forces a radical change in the insect population. Insects are driven into the trees where aphids do damage.

G. Most northern pecans have to be shaken down, and harvested before the first killing frost, or they freeze, and are spoiled.



II. Limiting factors in pecan production:

A. The previous northern pecan selections, which have been moved into Niagara from Ohio Valley, are Major, Colby, Busseron, Hodge, and Posey. They fill poorly, and really need another month of early September heat units to fill, then ripen.

B. The search for truly northern pecans is recent (1980), and many grafts and seedlings from Iowa, northern Illinois, and central Indiana are making viable nuts, which fill if there are hot weeks in October. They include Frits Flat, S-24, and Lucas.

C. Getting enough of the right seed remains minimal. Good northern seed comes from productive, far north trees with large, early ripening nuts. Trying to harvest these trees in the wild is proving difficult like trying to harvest Ontario/NY trees without tree shakers. Go to the native groves for a week, and you can get 2 lb./a kilogram of nuts. Graft several small trees, wait 10 years, and you get several pounds of nuts here. Recently, more nuts from grafted trees are ripening in Niagara.

D. The ranks of the northern pecans are declining. Diking is converting food plain to corn land, or flooding stretches of river bottom for wildlife (ducks). Where the only disruption is logging, the decline of pecan since 1900 is many fold.

E. Many early ripening far north pecan nuts are smaller than inch long. Those we have selected are an inch to 1 1/2 in./2.5 to 4 cm. Far north pecans are bright colored, high in oil and very sweet. Percussion shelling yields whole kernels quickly and easily. Varieties are all from the Maquoketa delta: Snaps, Deerstand, Diken, PK Jumbo, Oaks, Cornfield, and a few not yet proven.

F. A domestic northern pecan market will have to be built. The experience of growers in central Illinois is that once people discover northern pecans, the demand for cracked nuts sells the crop direct from the farm in several weeks.

III. Germination of pecans does not require cold moist stratification (only a week of aerated water soaking), although stratification is advised for stronger, more uniform stands.

A. Harvest pecans when the husks begin to open. Shake the pecans down by machine vibration, or striking the limbs where they measure approximately 3 in./7 cm. diameter. Drop cloths are useful in grass when harvesting large trees. Pecans that must be shaken down are PK Colby, Dejay, Fisher, Hodge, Sfoiles, S-24, Lucas.

B. Strip any hulls that come down attached. Wear gloves because the green hulls are juicy with juglone like walnut hulls.

C. Pecans may feel dry and taste crisp and palatable at drop time, but they usually require several days drying under cool airy conditions before going to storage.

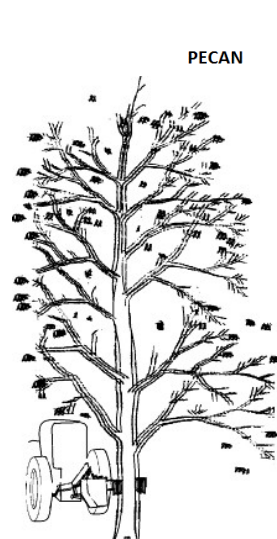
D. Store pecans in rodent proof airy containers in a cool location like a refrigerator crisper, unheated room, enclosed porch, or attached garage.

PECAN 90

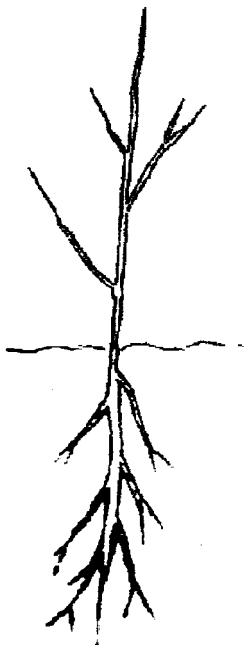
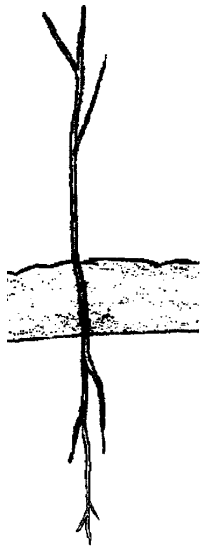
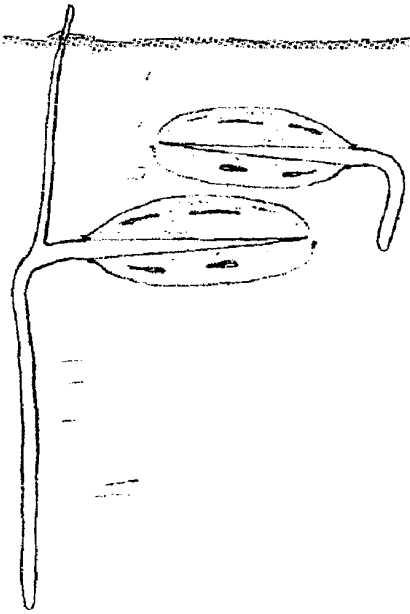


SHAGBARK HICKORY

SHELLBARK HICKORY



PECAN



IV. To fall plant:

A. Lay each pecan on its side with the point of the nut horizontal. Cover the nuts with 4 cm. earth, 2 cm. sawdust and enough earth to hold the sawdust in place. The root will emerge at the point of the nut, and push downward. As the ground temperature rises, the stem will emerge at the point of the nut and push upward. In late May or early June pecan shoots will break ground, looking very much like red or green party toothpicks with frayed ends. Where mice and squirrels are a problem delay planting as long as possible before freeze-up while removing mouse habitat, and baiting.

V. To spring plant:

A. Soak the pecans in water for one week, each day draining off and refilling with fresh water. Sow worked soil as above, but no sawdust. Water may need to be applied in a dry spring.

B. Lay two layers of orange diamond construction safety fence on the pecan seed rows. Broadcast mouse bait.

C. Just before the pecan shoots emerge through the ground, spray grass and weeds in the planting with Roundup+simazine. Hand weeding is appropriate if the planting is small, and weeds small. If pecans are up only the simazine can be sprayed over the planting without seedling injury.

VI. Take advantage of pecan's unique physiology when choosing a site for a pecan orchard. Pecans are suited to flood plain growing, and deal effectively with flooding, siltation, ice sheet movements and poor soil bearing capacity. Pecans have developed the ability to sprout from the root should ice sheet action carry away the stem.

The young stems can send out side roots should they be silted under. Young pecans have a single long dark tap root of nearly uniform cross section. Side roots are small and weak, unless forced to grow by intentional tap root pruning. The root crown is difficult to detect except that the long typically black (dark brown or even dark red is possible) tap root turns a lighter shade at the root crown, to grey-green stem. Pecans which grow as upland trees develop an enlarged root crown, but flood plain trees, which get silted, show no visible evidence of this feature. Because of upward siltation and poor soil bearing capacity of river deposited soil, a root crown is a buried, and unseen feature. After pecans begin to leaf they can take only a few degrees of frost without injury. Lately we have been getting a day or two of 80°F/27°C weather in late April that sends pecan to rush flushing, so have lost tip sprouts. A hard frost strips leaves and crop, but there always seems to be some nuts from side bud forcing. As trees grow larger there will be less frost injury due to ground frost. A year that starts warm, and continues very warm, supports the heaviest crops.

Frost, air pollution, and drying wind also injure flush and bloom, but return bloom from dormant side buds can restore some crop. River bottom land on major rivers (fluctuating water level rising to just above the root crown to falling 10 feet/3 m. below root crown) is suitable for pecans, if ice sheets can be controlled until the pecans have sized enough to take ice's rising, lowering, and shearing action. If the season is long and warm enough to ripen the chosen varieties, pecans will grow very tall and stand above cold surface air provided they stand on a broad plain where the cold air puddle is shallow. Sites for pecan planting need rich soil, high in organic matter and moderately basic to neutral in the surface layers. Root health below 5 ft./1.5 meters soil must be maintained. A thick plant cover must be evident, or the site must be worked-on for one or more seasons to raise fertility, improve drainage. Upland sites can be improved to make pecans productive by fertilizing, liming, working and seeding a legume mix. Upland sites (meaning sites on the high river bank, but not chestnut ridge sites) produce higher quality nuts than bottom land sites, if irrigated, wind moderated, and fed properly, because they are warmer sites, causing less frost, and earlier ripening.

VII. Transplanting and maintaining pecans:

A. Dig or buy northern pecans with an adequate root system. A third year pecan requires 24 in./60 cm. of root. The length of the seedling is about 4 ft./1.2 m. from the cut root end to the stem terminal. This is a good mailing size, and adequate transplanting size to recover in warm ground. The root diameter is a about 1 in./3 cm. The pecan transplant is not easy to dig, but requires the effort to make quick recovery. The planting hole is deep and often cold, so see Hickory 85 for advantages of temporary potting.

B. After grass has grown out 6 in./15 cm. in the spring, kill sod in a 7 ft./2 m. spot with Roundup + simazine spray. Spray at least one half day before digging the planting hole.

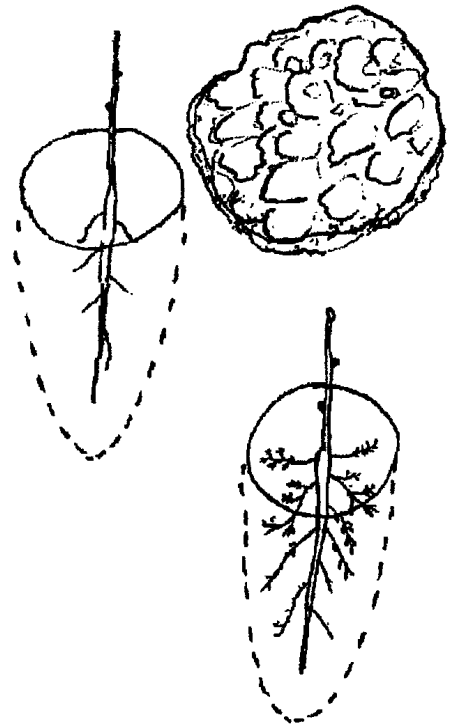
C. Dig a deep planting hole, broader and deeper than the root system to be planted. Typically, pecans are augured-in, into a post hole. Planting, after a growing season in a pot, speeds recovery by 2 seasons.

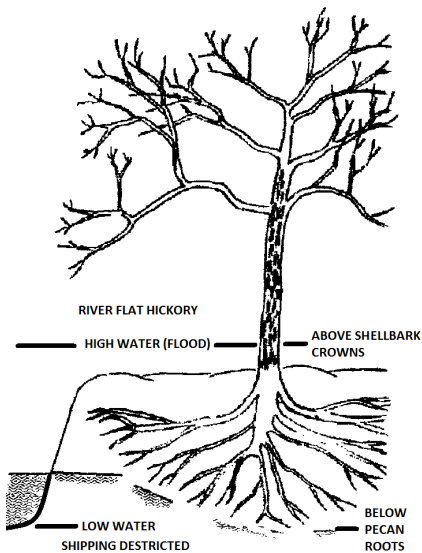
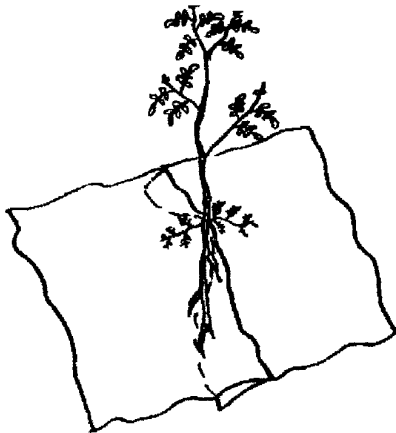
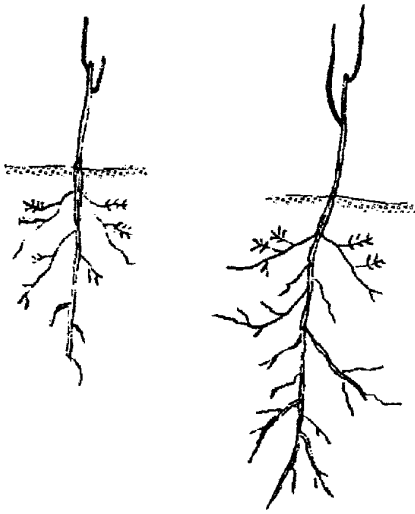
D. Mix re-plant soil with approximately 2 lb./1 kg. of bone meal with 2 lb. 14-14-14 Osmocote per 25 liters of re-plant soil. Digging in 2 lb. 14-14-14 granular a year ahead is effective.

E. Root pruned pecans might require spreading the roots for distribution in the soil. Spread the root system, and trim off dead and badly injured roots. Roots above 3/8 in./1 cm. diameter, which have torn ends, should be pruned to smooth wedge ends. Do not let the roots dry off. Allow as little direct sun on the roots as is possible.

F. Place the root system in the hole so that the root crown is 2 in./4 cm. above the original ground surface. Hill-up pecan trees.

G. Although pecans recover to full growth in three years with minimal holes, or elaborate holes, the homeowner should take the accompanying precautions with a grafted tree. Filter in the planting soil, while spreading the root system. Remove weed roots and grass clumps from the re-plant soil as you come upon them.





A fibrous root system on your transplant indicates a healthy, well nourished tree. This tree can be ruined by wadding together the roots.

Rather than wadding, it is better to trim off many of the hair roots.

H. Tug on the stem, and tamp to consolidate the soil, while keeping the roots extended.

I. Water to help consolidate the soil, but don't flood out the filtering in of soil, and tamping operation. Use a stick or shovel handle to rod the soil between the tree roots, or around a single spike root. Add brought in soil to hill the transplant with a 6 in./15 cm. pile, or more. The hill will soon settle and wash to invisibility, so add more soil if the root crown uncovers, or a depression is formed.

J. Stake a tree tube shelter over the tree, over toping the tree by 4 in./10 cm., tapping it into the ground a few centimeters so that mice do not enter. If wasps nest in the shelter spray some citron lamp oil on the nest, and around the inside of the tube. Paint the trunk with peach trunk paint, white latex paint mixed with Thiram, to be effective against sun scald and rodents.

1. Alternatively, paint, then stake a 4 in./10 cm. tube of octagonal plastic garden fence over the tree, to protect against rabbits, wood chucks, and deer rubbing.

2. Mulch with clear plastic film, if you have some, which heats the soil deeper than black plastic. Remove the plastic in July. Soak the soil with warm water at weekly intervals into summer.

K. Start right away broadcasting 15-15-15 granular garden fertilizer 2 lb./1 kg. per inch of trunk diameter, casting from the tree to beyond the branch spread at 2 month intervals through growing seasons/summers. Broadcast the fertilizer from the trunk toward and past some outer branches. Keep the fertilizer from the trunk. Any pellets contacting the bark must be removed before they burn the bark.

L. When weeds return, hoe and spray the soil with Roundup + simazine.

M. In future years maintain a 7 ft./2 meter spot of bare soil mulch around the tree. Spray simazine + Solicam as the last spray of the season/sprayed at first fall frost. Solicam is the cold season weed killer most used/economic on 1 year old seed rows. If intercropping is not practiced, maintain grass strips between rows.

N. In early years prune only to remove dead, rubbing and malformed branches. Later, typical malformation in older pecans is straight-up branching which have weak crotches. Some trees must be discarded for this defect, some trained. If two trunk buds grow at a node the up-right bud is the defect to be removed. The tiny bud is likely to have a branch collar that is a perfect bowl for a sought after horizontal limb. After some growth, cut the shoot of the bud that competes with the trunk, and grow the bud with the strong collar and low hanging branch. When grown under orchard conditions pecans maintain a conical shape, but we want a lot of strong crotch branches to choose among for best spaced, some for saving, and most to remove at 1 in. diameter to let in light. Southwest injury is protected against by the shade of the long low limbs. Descending limbs can gather more light, storing bearing energy above ground. Increased bending, due to nut load, increases the sugar storage by bending down limbs.

Noon shade on the orchard floor should be less than 50% at bearing, especially necessary in a pecan grove that needs heating.

1. Malformed branching in pecans is a constant problem. The variety Hodge is one with the finest flavor, and worst branching. Some growers say to rub out the primary buds on Hodge, except the terminals, and let all side limbs come from the lower of pecan's paired secondary buds because their branching is much more horizontal than erect. Erect branches in pecan have very weak crotches, and Hodge has a lot of blowouts. Poor crotches in pecan have to be pruned out before they blow out with shards trailing down the trunk.

2. Because some pecan varieties bear inside the canopy, bear on side buds rather than on terminal buds, effort is made to grow such trees flat. The terminal is removed. Side limbs are selected for strength and spread. If the shading can be moderated by side limb removal, the production, precocity, and ease of spraying makes flat the way to go. Lucas from Ohio may be a variety to try under flat culture in the warmest sites in Ontario.

O. Once nut production is underway, after about twelve years, expect to fertilize with about 1000 lb./500 kg. of 15-15-15 fertilizer per year. Supplements will be determined by leaf analysis. Foliar sprays of zinc sulfate and urea are common for pecan. Leaf analysis is tricky due to the ability of leaves to concentrate minerals which are tightly bound in the soil. Soil analysis and deficiency symptoms in the leaves can indicate binding (non-ionization). Mulching and keeping an active soil flora and fauna frees up bound minerals. However, when you have this culture perfect, the pecans can go to over production, where you have to shake down half crop of half size nuts to keep the nuts sizing and filling without competing for nutrients. Then trees keep bearing yearly.

P. Before harvesting nuts, prepare the orchard floor by mulch mowing to shred debris.

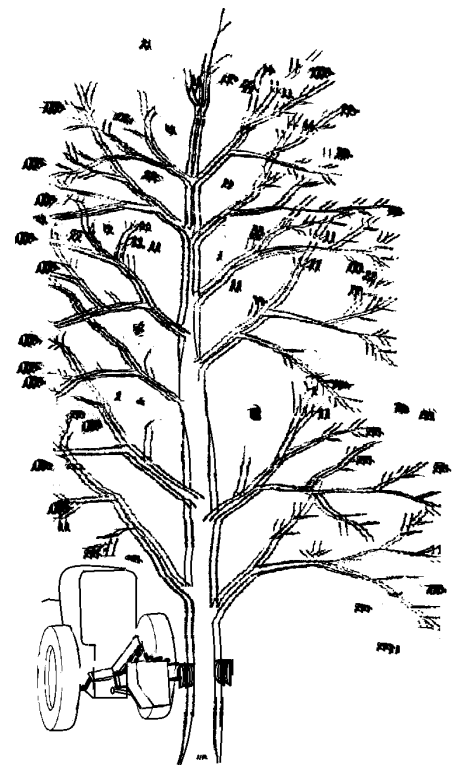
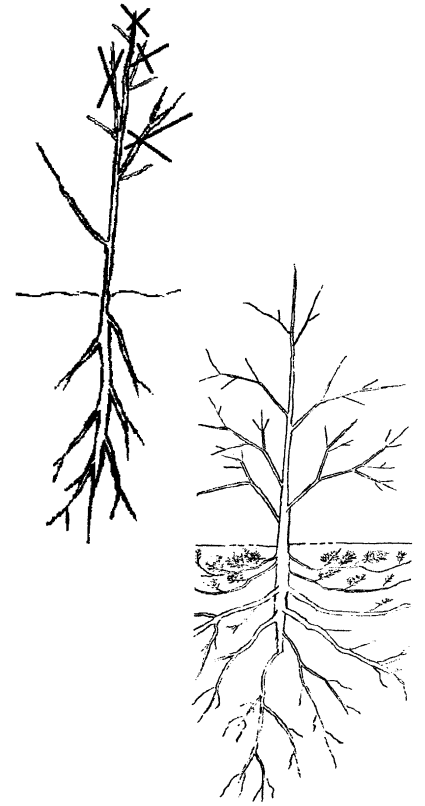
Q. Pick up all nuts and shred downed leaves, hulls and branch-lets to eliminate habitat for pests and disease.

R. If aphids become a problem, as they often do where a single crop is grown, use a combination of judicious spraying, and entertaining habitat; pests, and predators on the ground cover until predator populations take control.

S. Pecan weevil is not expected to be a problem in Ontario. Only early-fill hickory/pecans in the mid-west are affected. Highly weevil damaged nuts are associated with selections for moving north.

VIII. **Harvesting and storage** of northern pecans is presently a commercial operation in central Illinois and northern Missouri. It requires dead branch rakes, ground rollers, tree shakers, drop cloths, pick-up machines, cleaning machines, cracking machines, chlorine baths, blow driers, and cold storage.

A. Tractor mounted shakers grasp the trunk at the 5 ft./1.5 meter level, or up, to rapidly vibrate it 3in./8 cm. back and forth. A standing wave is set up in the trunk to roll off pecans. Limited shaking by hand is accomplished by giving each limb a sharp rap where the diameter approaches 4 in. Ripe pecans hang from a filament in their open husks for days, weeks, and even months (but not mine which fly away.)



IX. **Spacing for pecan trees** is based on spacing observations for productive trees growing in orchards under Lake's Region conditions.

A. The most fruit are produced at the ratio 1:1500, .067%, butt area 30 sq. ft./ac., which should also produces the most nuts. (approx. 50% noon shade on the ground).

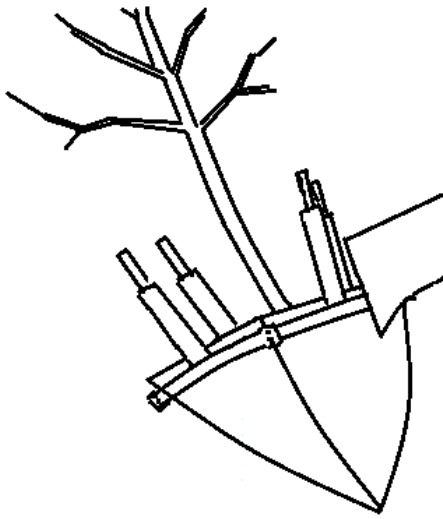
B. Doubling this ratio produces the most fiber. (approx. 70% noon shade on the ground)

C. Decline in both nuts and fiber production is uneconomical and indicates injury to the trees. (Also, nut production should be kept below 50 lb. per ft² of trunk area {730 lb./acre} by shaking off 50% of half size nuts {leaving two nuts/ raceme flower strand}, or the return crop will be small and winter injury could occur as flagged by brown streaked new tip wood.)

D. Tree spacing has to increase with time due to growth competition. This dovetails with the need to sort out selected seedlings. Odds are that one in ten select seedlings can become permanent.

E. Tree spades are available to move large trees in fall without transplanting shock. These tree spades will be used to move selected trees rather than chopping them down. More likely, grafted selections will be set in at the more permanent diagonals and rows.

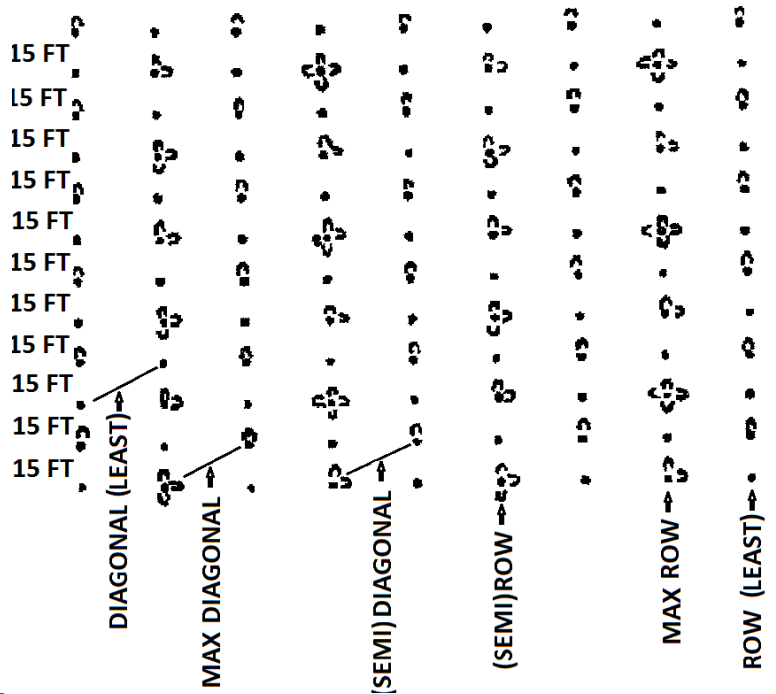
F. The years-until-maturity, and the production rate of pecans are slower than fruit trees, but pecans are much longer lived, and their logs are much more valuable.



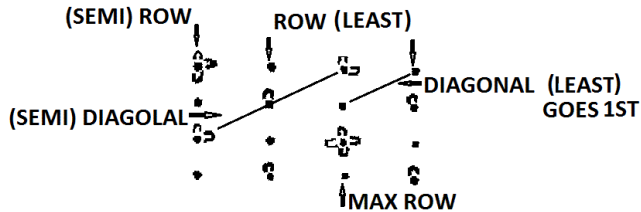
PERSIAN/BLACK WALNUT / PECAN / SHELLBARK HICKORY / HICAN / HEARTNUT HYBRID	BLOCK	LAND AREA SQ FT	NUT TREE THIN DIAMETER, "START DENSITY" AT 30 SQ FT/Ac LIMIT CM INCH		TIMBER TREE THIN DIAMETER, "END DENSITY" AT 60 SQ FT/Ac LIMIT CM INCH	
	FT X FT		CM	INCH	CM	INCH
1ST THIN	20 X 15	300	15.7	6.2	22.1	8.7
2ND THIN	40 X 30	1200	31.2	12.3	44.2	17.4
3RD THIN	60 X 45	2700	47.0	18.5	66.3	26.1
4TH THIN	80 X 60	4800	55.4	21.8	88.4	34.8

PECAN ORCHARD - SPACING FOR THINNING TO 80 BY 60 / 1 TREE ON 4800 SQ FT

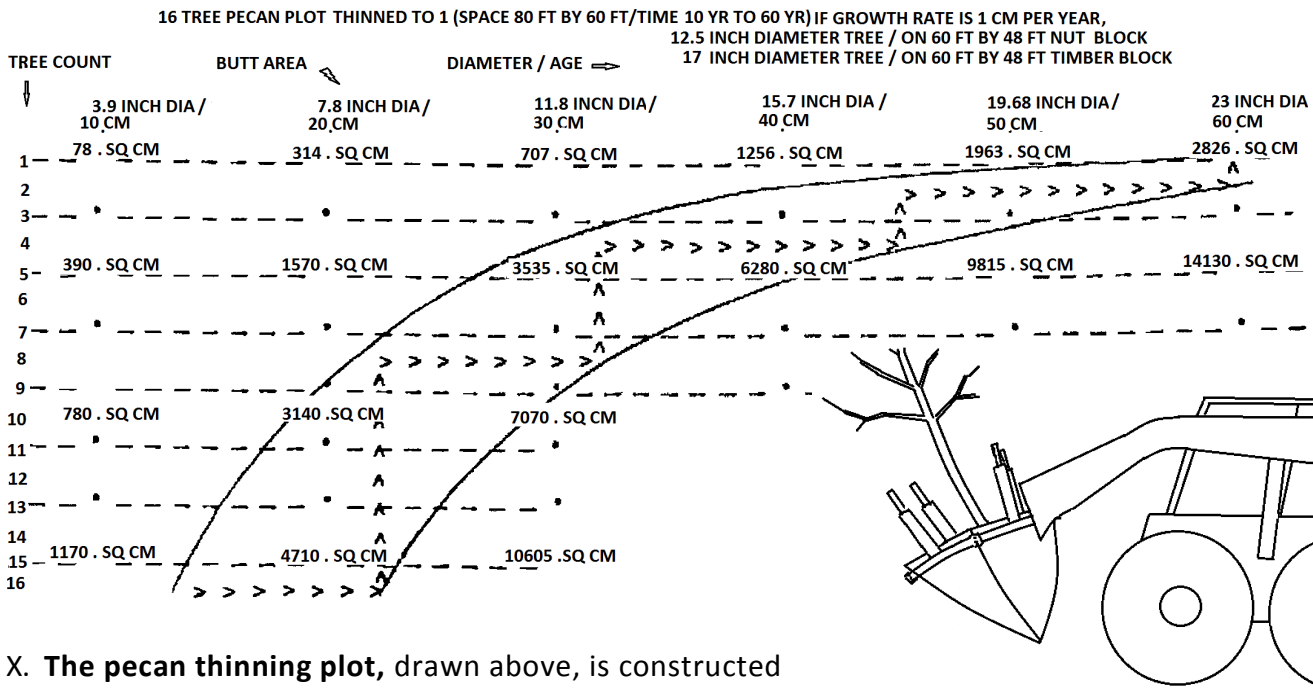
20 FT 20 FT 20 FT 20 FT 20 FT 20 FT 20 FT 20 FT



16 PECAN TREES ARE THINNED TO ONE TREE,
1 TREE ON 4800 SQ FT/ 80 FT BY 60 FT.

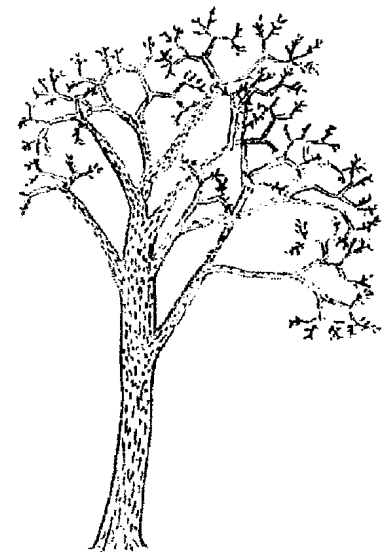


- 1ST THIN REMOVES DIAGONAL (LEAST) 8 TREES GO
 - 2ND THIN REMOVES ROW (LEAST) 4 TREES GO
 - 3RD THIN REMOVES (SEMI) DIAGONAL 2 TREES GO
 - 4TH THIN REMOVES (SEMI) ROW 1 TREE GOES
 - MAX ROW BECAME PERMANENT 1 TREE STAYS
- 16



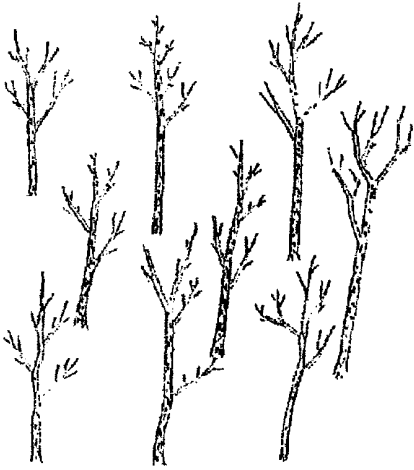
X. **The pecan thinning plot**, drawn above, is constructed from the above six spacing factors. Through the years the typical planting area, containing initially 16 trees, is cleared until one selected tree remains. The maximum diameter of a productive pecan looks to be about 24in./60 cm., 9 trees per acre.

A. Pecan trees will shade each other without the rapid decline experienced with most other hardwoods. Reasons for this ability to tolerate shading are deep root systems which are able to efficiently tap and mine the soil, and an open foliage which allows light throughout the tree's canopy. Allowing a slight crowding in pecans, will be beneficial in moderating strong winds. The thinning plot takes these observations into account by thinning the 16 tree base group before maximum fiber production is reached. Northern pecans can **not** be water stressed, or nut sizing stops, and filling is delayed. A hot, dry summer will require irrigating to deliver 1 inch/3 cm. of water over the orchard per week (better to double the water rate at sizing/filling time.) Drastic pruning can aid pecan production by allowing light and water efficiency. While pruning remember that un-shaded limbs which bend down gather more light and store more energy above ground, producing more nuts, than ascending, trunk competitive (vegetative), un-shaded limbs. Prune off entire limbs and sectors of trees which extend toward more permanent/productive trees. Prune July/August, thereby directing the tree's energy away from vegetative growth next spring which dormant pruning would stimulate. Spray Avaunt insecticide on pruning wounds to protect against borers. Try to maintain a nut producing pecan grove at about 50% noon shade on the orchard floor.



XI. **Projects with pecans:**

- A. Grow out seed from the earliest ripening, largest and most northern pecans.
- B. Grow out seed from select seed in breeding orchards of northern pecan selections.
- C. Cross the best, earliest far north seedlings from northern selections.
- D. Explore for, and survey bottomland where native pecans crop unde-



XII. Where pecan timber is grown, the logs are treated like black walnut, and should be comparable value. Pecan will be a novelty in Ontario/NY. Selling them for the right price may be difficult. The market for pecan wood in the deep south is expanded by hurricane injured trees coming onto the market, but log prices are low while the lumber stocks increase. Pecan is a blond wood like Circassian walnut, but without the curl.

XIII. Small quantities of pecans may be dried by spreading on newspapers or hanging in wire trays under dehumidified or airy conditions. After about one week's drying the nuts are crisp and tasty. The storage has to be cool and dry. Store nuts in a ventilated, rodent-proof container in an unheated room, enclosed porch, or attached garage.

XIV. Most northern pecans are small and tedious to crack, although hand held percussion shellers strip the shells, and leave whole kernels. Most northern pecans are sold cracked, but with "saw dust" screened or blown off, and large shell fragments remain. Once mechanical shellers were introduced, the demand for cracked northern pecans has accelerated, selling out crops in a few hectic weeks, which used to sell through the winter. Northern pecans are bright, rich in oil, and sweeter than southern pecans (likely due to cool ripening and curing.) Either fresh or cooked, pecans have a melting buttery flavor. They bring texture and balance to many sweet recipes.

XV. Pecan cultivar propagation is usually by top working in late May. Root stocks should be pecan, shellbark hickory, or hican, but northern pecan root stocks favor low land, moist sites. Pecan root systems are adapted to summer feeding in moist rich soil. Hickory rootstocks (other than shellbark) seem to take a summer vacation. The favored size of stock is finger diameter at the height of one meter. Graft unions in outdoor grafting are most often successful at over 4 ft./1.2 m. height due to too much bleeding near the ground.



A. The three flap (or four flap for unions greater than 1 in./2.5 cm. diameter) method of grafting is recommended for pecan. Pecan has a phenomenally healthy bark which resists infection. Wounded pecan bark has twice the life expectancy of wounded walnut bark.

1. **Thee flap graft materials:**

a. Materials are smooth bark stocks of 5/8 in./2 cm. diameter, pre-waxed scions of same diameter, extra heavy aluminum foil, Teflon plumber's thread sealing tape, weatherproof electrical/hospital tape (Blenderm from 3M is preferred for its ability to stretch and stay stuck), masking tape, sharp knife able to slit paper, and pruning shears.

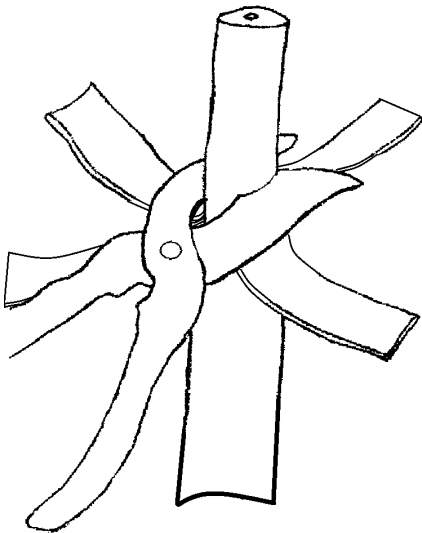
2. Method of making three and four flap grafts: (see Saddle-Flap on p.75)

a. Just after frosts in late May match a terminal of the stock to a scion. The scion can be millimeters larger or smaller than the diameter of the wood within the bark of the stock. The reason is that the stock is peeled, but the scion is shaved. The depth of shaving allows the size of the scion to range, but shaving to leave big islands of very thin cambium is best, then the scion is only millimeters thinner than the stock.

b. Prune off the terminal 4 in./10 cm. above where you want to butt the union. This will give you nominally 10 cm. flaps of bark on the stock.

c. With the point of a knife slit the bark of the stock vertically (axially) so you can pinch to moisten, and peel down three flaps. (This is like peeling a banana except pinch the top of each flap against the wood to start it sliding off. Shade this operation with your body. Also, flaps are to be exposed to the air as little as possible, and not at all to direct sun. Thus, as shown, each flap is peeled about 12 cm., core plug clipped horizontal, then core temporarily replaced, and flaps stuck back to their original position with masking tape to temporarily prevent drying and UV light.)

d. Open the flaps of bark, and shear off the 4 in./10 cm. plug of wood. Immediately replace the plug and flaps to their original positions, as above.



e. Shear 1 cm. off the base of the scion in order to expose fresh wood. You are to shave the scion to match/butt most of the sheared plug.

f. With a knife that is sharp enough to slit paper, shave three 8 cm. long shavings from the scion, drawing through the cambium and staying narrower than the flaps, so that each flap will cover each cut on the scion. Cutting just gets through the cambium enough to leave small islands (feathers/peninsulas) of white cambium on the cream colored wood. Shave very little, to no, wood.

g. Stick the scion, replacing the plug of wood, turned to best butting.

h. Seal the union with Teflon, wrap from base to leave no gaps in the Teflon membrane, or air pockets in the union. The Teflon should be slightly stretched lengthwise, but also widened with a finger tip, or it will become a string.

i. Bind the union with plastic tape that is weather proof like Blenderm for strength, and with two turns at the top of the flaps to insure Teflon staying sealed for weeks by which time it has welded. Blenderm is preferred because it retains stickiness so that it can be reattached when, and if necessary. Blenderm, also stretches to allow a year or two of growth until it degrades.

j. Adding a splint for supporting the graft has not been necessary, but will probably be necessary in a wet season which may promote extensive growth that may blow off.

k. Rub competing growth and buds from the stock as they appear.

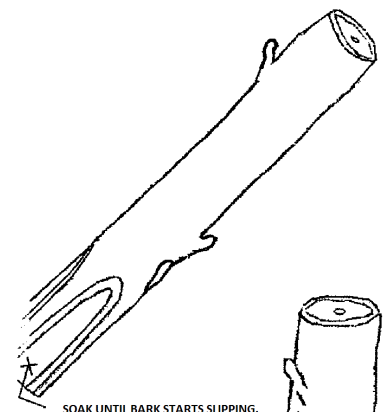
XVI. Pecans cropping in Ontario/NY:

A. Campbell's NC-14, S-24, PK Colby, Lucas, Fritz Flat and Fisher are 3 cm. long nuts which just ripen in Niagara. In the hot long (three weeks longer) season of 1991 these pecans had as early ripening as is typical in the mid West. These named pecans must be shook down and gathered up before frost.

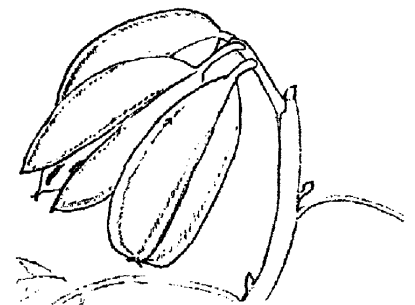
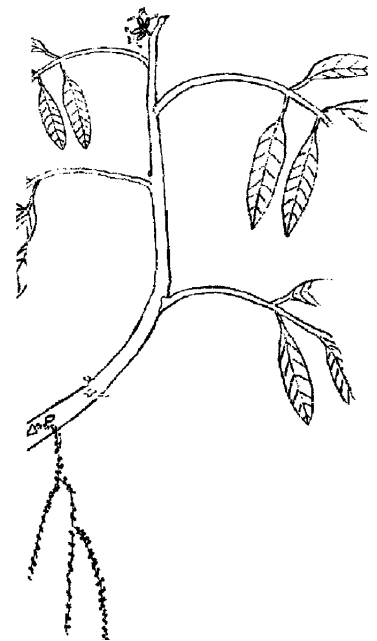
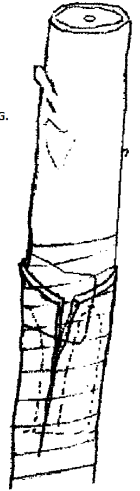
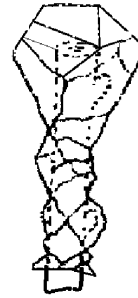
B. Snaps, Deerstand, Diken, Pk Jumbo, Oaks and Cornfield are smaller, and earlier ripening. Their tree health indicates adaptation near Windsor through Niagara through the Finger Lakes. Their nut size indicates a need for irrigation, and for crossing with larger selections above.

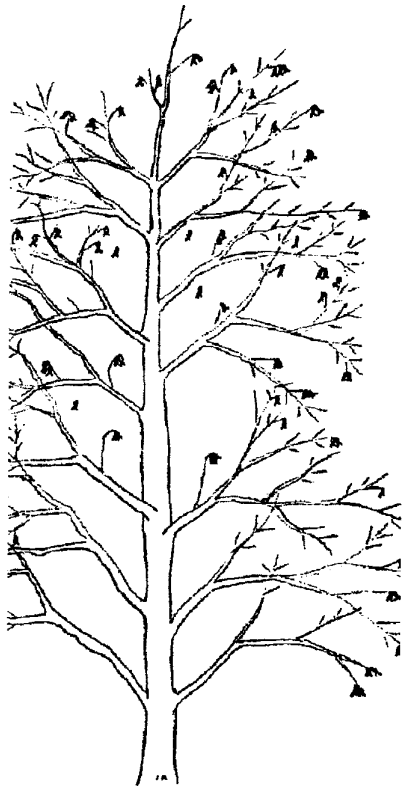
XVII. Our report on pecans is not complete. We advise that the exploring of native groves continue due to yearly discoveries. Now, however, growing and evaluating past discoveries is consuming the time we once devoted to exploring. The effort was worth spending because we can look back at it, pointing to the discoveries, and the selections and many seedlings to be evaluated. When we started we did not know that we would find any pecans, though we hoped for new pecans for Ontario.

A. The discovery of the Snaps paper shell pecan near Bellevue, Iowa is a breakthrough because it shows early kernel filling in a pecan, weeks ahead of typical pecans in the Maquoketa groves, and with hickories in Niagara. Snaps' fault is a thick hull that delays drying, splits late.



SOAK UNTIL BARK STARTS SLIPPING. HOWEVER, ISLANDS OF GREEN CAMBIUM CAN BE LEFT ON HERE.





B. The discovery of the Abbott pecan (bitcan) at Fulton, Illinois may answer why there are such strange looking bitternut x pecan trees and shells at Savannah, IL (We found shells, no nuts.) Fulton and Savannah are next to each other at the edge of a massive lake bed which drained many years ago when an earth quake changed the course of the Mississippi. The Abbott pecan has pecan shape (actually similar to 3 bitcans on the Mississippi high bank at Fulton), and has a kernel which looks like a long bitternut kernel. The parallel grooves of pecan are replaced with the convolutions of bitternut, convolutions of a brain. Abbott is like Snaps in thin shell and flavor, but needs cold storage to not go rancid, and turn red with oxidation.

C. Select seedlings from selected parents are eclipsing their parents.

XVIII. The Northern Nut Growers Association has promoted the growing of nuts in temperate climates since its founding in 1910. Through its network we made a northern pecan seed distribution, similar to SONG's heartnut seed distribution. The NNGA Pecan Seed Program caused us to explore for and collect pecans. We distributed seed in 1979-80 and questionnaires have returned indicating that home gardeners prefer to start pecan seeds in pots.

A. Reasons for using pots:

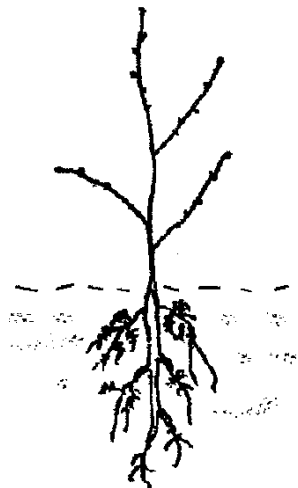
1. Squirrels are much too numerous and adept at scamming nuts. One grower reports the theft while he was re-bending his wire cover which had become too cramped. Buried nuts are easily sensed by squirrels although they usually wait for germination before "spring harvest". They harvest planted nuts like they harvest apricot seed except instead of fruit halves on the ground they leave dead seedlings.

2. The heat necessary for pecans to germinate is best controlled in a greenhouse, or south window. Pecans have a heat-trigger. Black walnuts, butternuts, heartnuts, and filberts have almost a freeze-crack-trigger, between chestnut, and pecan. Thus, after stratification walnuts grow at the first rise of temperature while pecans/pawpaw wait for real heat.

3. Gardeners need to mark filbert, pecan and pawpaw rows, or during cool or dry weather these nuts are too slow to emerge, and gardeners forget where they planted rows.

B. Planting nuts in pots is tricky because:

1. Pots have to be deep to allow adequate tap root expansion and air pruning of the tip to initiate extension of side roots, rather than the curling of the tap root at the bottom of the carton. Milk cartons with end flaps extended at both ends and filled with high organic potting soil produce vigorous root systems. Potting valuable strains of pecan and pinion pine is worthwhile. RootMaker, Spencer-Lemaire in Edmonton, Stuewe & Sons make deep starting pots, about 4 inches square by 14 inches deep. Air pruning of the tap root usually coincides with stem emergence. A screen pan, supported on coarse gravel, will hold the soil above, air below, and allow drying of the root tip at that interface.



2. Tiny soil insects must be controlled, or they often infest and kill the embryo of a cracked, but dormant nut due to too short stratification. Embryo expansion and growth should coincide with shell splitting and root elongation.

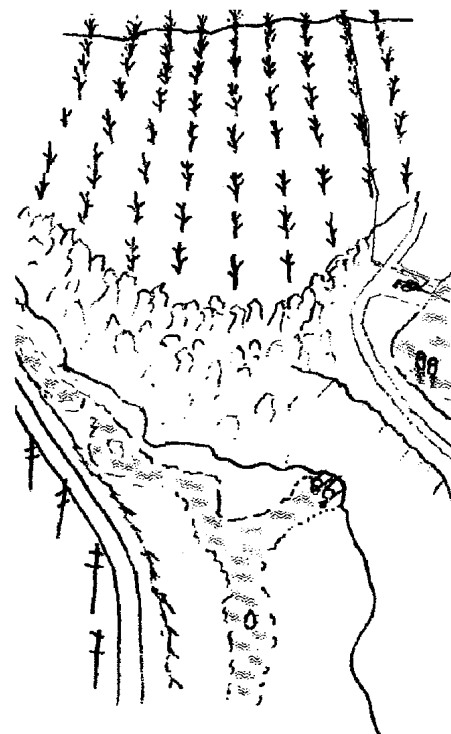
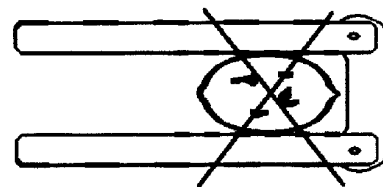
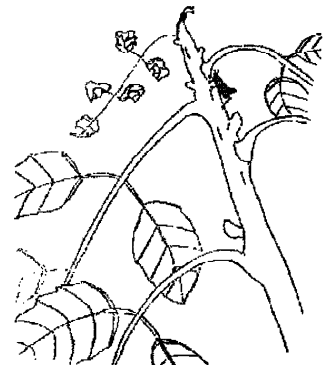
3. Pecans need wind action to sturdy-up their growth. When the seedling is approximately 8 cm. high it must be moved outside to open shade, or screened by a board if planted out in full burning sun.

4. Pecan seedlings should be planted out, or repotted to a larger carton after eight weeks of growing. When removing a carton do not pull the seedling. Slit the carton to preserve the fragile root ball. Root balls must not be disturbed while root balls are newly growing.

5. Do not try to hold pecans in leaf through the winter. Pecans need a rest period after summer's growth. Maintaining winter growth indoors results in the pecan "resting" through the second growing season.

6. The pot must be **planted** outside in ground just like as in spring planting, not set above ground, or the root will freeze, and die from being frozen by more than a few degrees of frost during winter.

XIX. During the past fifty years commercial pecan growing has moved north as far as central Illinois from the Gulf states. The productive capacity of the native trees had been known for generations, but harvesting and cracking of these smaller pecans waited for tree shakers, mechanical harvesters, and percussion type end cracking machines to reveal their usefulness. Cracking machines deliver a mixture of bright whole kernels and shattered shells. Pecans are sold with shell fragments (this probably holds freshness), but screening and blowers remove dust, and small pieces of shell. Customers now order ahead to insure a supply. A similar market can be built in Ontario/New York.

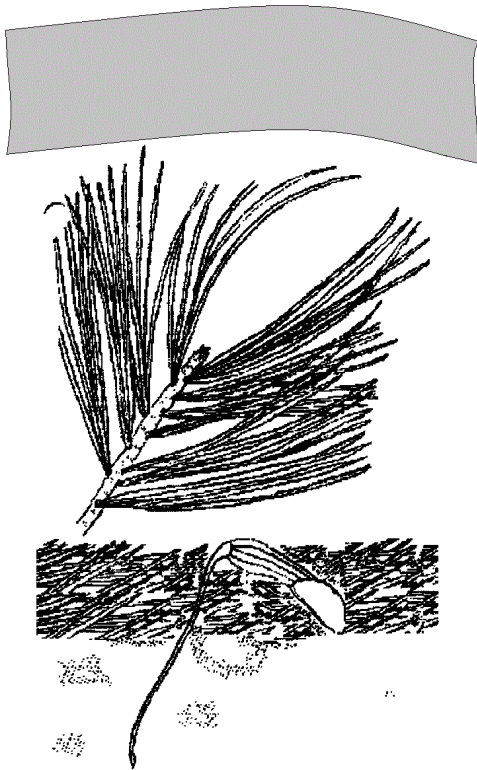


NUT PINES

WESTERN WHITE PINES (*Pinus monticola*), (*Pinus flexilis*)
(*Pinus strobiformis*)

PINION PINES (*Pinus edulis*), (*Pinus cembroides*)
(*Pinus monophylla*)

SWISS STONE PINE, SIBERIAN STONE PINE (*Pinus cembra*)
KOREAN STONE PINE (*Pinus koraiensis*)



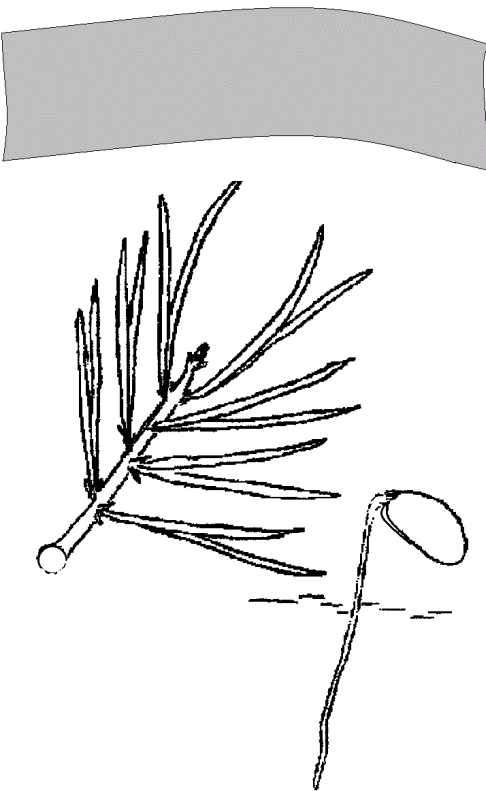
I. Western white pine from British Columbia is the closest to a native nut pine in Canada. Western white pine, and *P. cembra* stone pine, are easily mistaken for eastern white pine except that they are more thickly thatched with needles. Eastern white pines, trimmed for sale as Christmas trees, are identical. Korean pine has sparse needles like eastern white pine, but holds them erect rather than flowing like eastern white pine. White and stone pine needles are frosted white on top, and are bundled in fives. These trees grow to be large timber trees. Two needle bundels are in typical pinion, or hybrids with single needle pinion (*P. monophylla*).

A. Korean pines have large wingless seeds, as do all nut pines, the size of dry kidney beans. Swiss and western white are sized like white (navy) beans, or beech nuts. Eastern white pine has winged seeds 20 to 30 times smaller. Eastern white pines mature cones in one year while western white, pinion, and stone pine all take two years. The pinion pine from New Mexico/Arizona to Utah are productive on a seven year cycle. Nut pines mature cones in two years, releasing cones every year because they start new cones every year, which they hold for two years. All like acid soil.

B. Pinion pine, except for its grey-black-bark, looks like a short needle Scots pine which is well trimmed. *P. monophylla* is single needle while the other pinions are two needle (like Scots) except hybrids of these pinions can have one and two needle bundles on the same tree. Cones are like Scots but fatter, stubbier. Pinions have large seeds like Koreans, but hulls are much thinner. Stone pine nuts are easily confused with pea gravel, hence the name, and have to be cracked like hazel nuts. Southwestern United States Indians shake pinion and wood embers together to char and shrink the hulls for easy kernel extraction.

1. We have not explored for the best nut pines for Ontario. Pinions, the tenderest mentioned here, are found in the New Mexico/Utah Rockies as high as 2,500 m (8,000 ft). They are found growing in the Geneva Horticultural Experiment Station next to the greenhouses. Stone pines grow from the Alps to Siberia, also Highland Park, Rochester, NY. To get the best sorts growing here we have to watch what the landscapers and Christmas tree growers are bringing in. Usually a tree which prospers, and remains ornamental will be productive, and have large seeds if it is the right species.

2. Korean pine is the nut pine which produces the most nuts in Eastern Canada, or China. Henri Bernard collected from mature Korean pine near Montreal, Quebec.



The forestry station at Orono has mature Koreans. The Royal Botanical Gardens in Hamilton and Highland Park in Rochester, N.Y. have Korean, and many other nut pines. So why do we have to graft on Scots pine to grow them on garden soil? They need a pH 5 soil to grow vigorously. Garden soil is pH 6.5 and likely binds the iron, etc. that Koreans need. Garden soil may be too wet sweet, and rich for pinion pine to go dormant for winter because I **cannot** grow them past three years when, and where, they stand above snow. Local Christmas tree growers say they **can** grow them with no problem on typical stony Christmas tree sites.

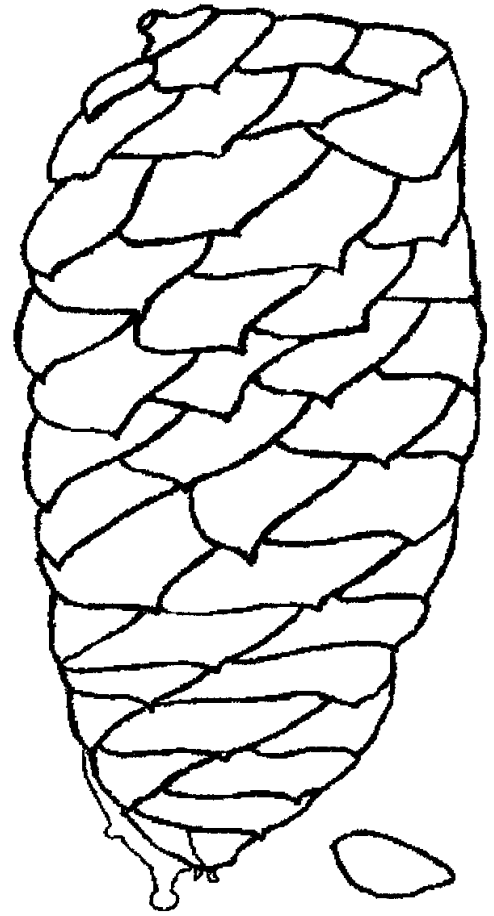
a. A Korean cone can contain nearly a pound/half a kilogram of seed. Cones come down during winter storms. In nature the cones remain encased in pitch for years. I have looked for squirrels to be bound up in Korean pitch, but no such luck. They harvest in fall, gnawing through pitch, closed scales, and ends of seeds to extract the kernels, but usually do not get all seeds. The seed remains viable for years while the pitch erodes, and cone decays.

(1) Seed for planting has to be removed from the cones and stratified in damp peat moss at 40°F/3°C for three months. To break apart cones, chill them to 0°F/-20°C, and while cold, hammer them apart. Alcohol or turpentine will clean up pitch.

b. Pinions are easier to collect than the stone, or the too small western white pines. Their cones will shake off in late September. Don't delay gathering, or the pinion cones will open, and the seed will scatter.

(1) Pinion pine germinates (sends root) in the fall, like white oak, beech, and chinquapin. Stone pines seldom have roots extended after prolonged stratification.

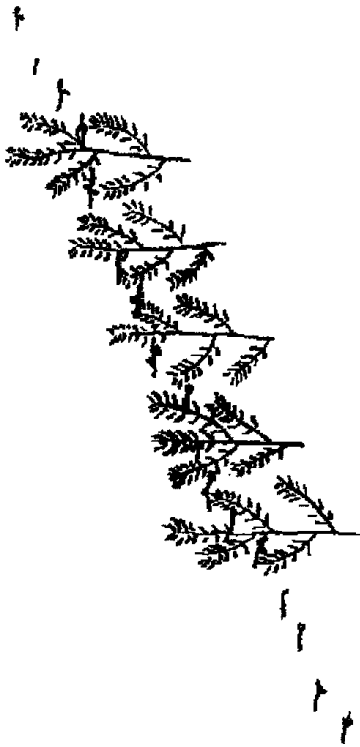
(a). Stratifying allows nature to run her biological clock until the hours of chill are complete, and nuts germinate (or trees flush). Temperature goes up and down; growing days mixed with freezing days. This fall-winter-spring interval (the chill interval, not frozen interval) has to be recorded in the nut (or the tree), and germination (or flush) is triggered by moisture and heat after the required hours at moist cold. Native trees have about 1,500 hours at about 40° F/3° C for their chill interval. Southern trees have a chill interval of only hundreds of these hours. White oaks, beech, and chinquapins, which start roots in the fall, but they only start tops most of the way through spring. Single leaf pinion, *P. momophylla*, needs partial shade the first year after germination, in nature under Utah juniper



KOREAN STONE PINE



PINYON NUT PINE



(b) Pinion pines, pecans, hickories, and Persian walnuts retain porous shells despite drying. Soaking and early March planting will often satisfy chill, and deliver vigorous seedlings by late June.

(c) Stone pines, filberts and butternuts seal their shells upon drying. They need months just to absorb enough water to start germination. Store bought pecans and walnuts often germinate better than seed from local growers. Unless these are tested for germination only after 1,500 hours at 50°F/3°C, do not expect them to be hardy. I have tried to germinate the Korean pine nut kernels from China, but these must be irradiated.

C. Korean pines make poor growth in our neutral soils. They are adept at growing in peat/acid rich soils. Even starting them with blueberry culture may not work due to the need for pine fungi. Litter from red/white pine usually contains the required fungi. Partial shade from screens is of great benefit while the pines are young. Stone, pinion and western white pines benefit from the practices used with Korean pine with a liberal application of zinc phosphide coated grain set before pines come up. Koreans grow much better grafted on Scots pine, or on the acid soils of Eastern Ontario, or Quebec. Well water needs some sulfuric acid conditioning.

D. Thatching is laying a pine needle straw on young pine seedlings. Red pine is the best straw because of the open airy thatch its large needles make. Light and rain come through from the top while the pine seedlings come through from the bottom. Surprisingly, even older needles, not just new growth, emerges. Besides moderating surface conditions, and adding mulch nutrients, the press of straw, poison grain, and the struggle-up, protect the seedlings from frost heaving, mice, and birds, which are the main cause of death in open beds. Screen off birds.

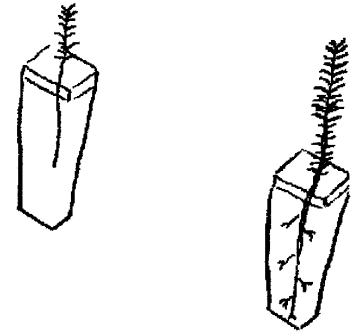


II. Planting pine nuts is like planting beans (except in beds, not rows), about 2 cm under soil plus 4 cm. under pine needle litter. Pines are planted in beds, and thereby make a shaded ground cover. Other shade screen is added as cover to get them started. 3 cm. on centers is good spacing for pinions; 4 cm. centers for the others.

A. Shade screen, frequent rhododendron type liquid fertilizer treatments, and frequent transplanting are the rule in pine production.

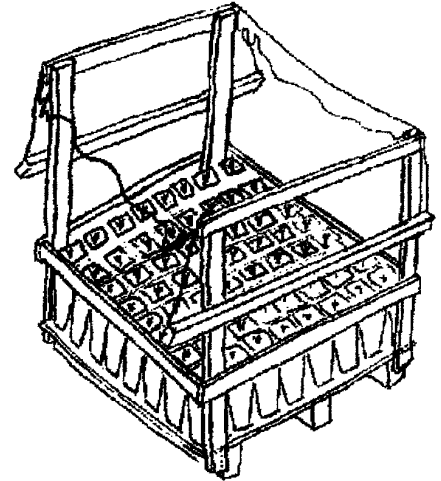
B. Birds are keen to take sprouting pines, pecans, hickories and Persians. Row cover fabrics (Reemay, etc.) protect these germinating nuts. Mice and squirrels have to be controlled. Baits to investigate are zinc phosphide orchard bait, or the second generation anticoagulants, Maki or Havar. Mice go for Swiss stone pine first, especially in beds under snow cover. Homeowners will find hand weeding semi-convenient, but most growers should check out the herbicides: Roundup + simazine (before seed is up, not an over-the-top spray), then simazine, Enide, Goal, Poast, Fusilade, Solicam, etc.

C. Transplanting nut pine is best out of seed starter tubes. Small seedlings with their spike of soilless starter mix are set into holes made by a matching spike, or core tool. Soil is returned against, and atop the soilless mix pressing from the side and stepping down the earth core. Korean pine needs a higher acid soil site.

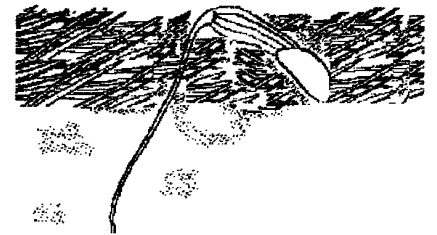


D. Pinion pine has a long tap root with few side roots, much like pecan and hickory. Check with the grower. Like with pecan and hickory, one has to dig a deep hole and plant all the root. Little growth is to be expected a through first season after transplanting. Pine should have side roots clinging to a planting mix for back-up in planting into cold ground.

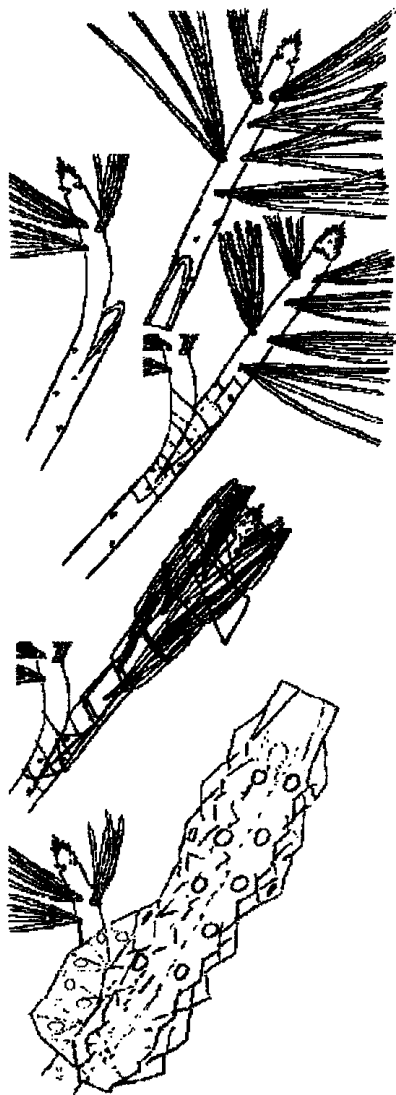
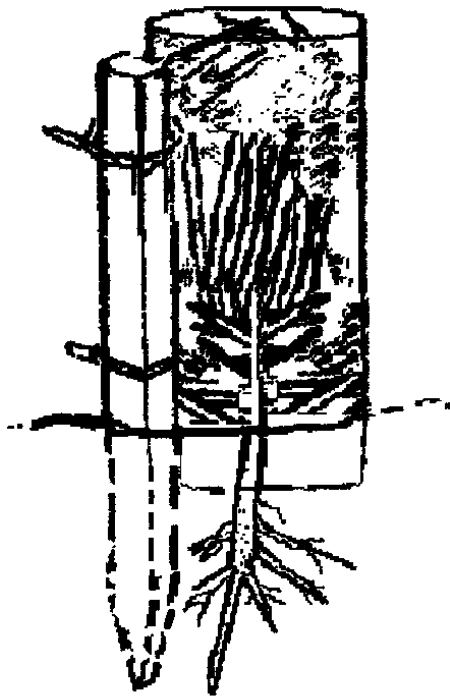
1. Potting valuable strains of pecan and pinion pine is worthwhile. RootMaker, Spencer-Lemaire in Edmonton, Stuewe & Sons make deep starting pots, about 4 inches square by 14 inches deep. Southerners plant seed directly in these, but locally they receive one year pine seedlings. These catch hold quickly and fill the root space, if grown in an above ground growth chamber. A convenient solar chamber has 50% shade from fabric, or lath. The chamber is made by covering a pallet with boards and plastic film. Side rails are nailed to the pallet allowing Reemay fabric to be draped over. Rainwater will enter, but the fabric must be lifted to add supplemental water, acid, and fertilizer as necessary, as the containers become light. The pallet is set in a cove location, out of the wind, but in noon sun before screening. Quick warming of the potting soil in the solar chamber gives rooting success, but the containers have to be set on un-frozen ground for winter, and insulated with some sand/pine straw on, and between the pots.



2. Container grown seedlings have to be protected in the fall. If left unprotected, the pot freezes, water can no longer be taken up, the plant freezes, dries, and dies. Container grown seedlings should not be taken inside a heated room for the winter. Part of the problem here is that they need their chill interval to start growth properly in the spring. Cool storage as in a white plastic lath house, or a damp, unheated basement may work. Watering will usually be necessary. Mice can eat the entire seedling.



3. In spring the seedlings are successfully planted as plugs into same size (about 8 in./20 cm.) holes augured, or driven at permanent locations.



III. Grafting pines can be more convenient than growing seed:

A. Scots or Austrian pine stock is usually handy and more adapted to Ontario conditions. Korean pine tips from local ornamental selections are the assumed scions. Scions are gathered in March as the longest tips of branches in full sun light. Dip cut ends in wax. Storage is by double bagging in plastic bread wrappers with moist paper towels in each bag.

B. Years of growing time can be saved because pines grow very slowly while young. Grafted pine bloom a few years after grafting.

C. Deer often clip off low pines, but terminals at shoulder height are usually safe.

D. The best varieties can be kept true, and bred.

1. Competing Scots foliage has to be removed after the first month, or it will out-grow the graft, starves the graft.

2. Materials: 1 in./3 cm. (approximately) wide clear polyethylene strips about 12 in./35 cm. long, 1 in./3 cm. (approximately) wide white polyethylene strips about 18 in./45 cm. long, electrical tape, masking tape, pencil & tags, pruning shears, grafting knife, wind splints cut from cedar shingles.

3. **Grafting Korean pines - side graft method:**

a. When weather warms and growth begins in early May match the stock to the scion. Clip, slice, or rub off the needles at the union and 2 in./5 cm. above and below.

b. Look at the core of the scion to see the distance between cambiums at the center/diameter. Perform a side graft by cutting a long slice into the side of the stock to behind the cambium to match cambiums, and a long point to the middle/diameter of scion, and shave scion to match what you see at the stock. A un-waxed, moist scion must have a fat tip bud. This could be a good time to dip the scion into IBA at a concentration equal or higher than used in rooting cuttings.

c. Wedge the scion into the stock. The mechanical union should hold the scion in place and show the cuts as a double line, small valley in between. Matching diameters could put cambiums on each other. However, matching diameters is seldom possible when grafting on the large terminal of an older stock, so only cut shallow to behind the cambium of the stock. without removing a chip.

d. Wrap the union with a complete seal of stretched-on plastic strip, which is friction-tuck-tied-off at the top, and the friction-tuck-tie is bound with loop of masking (easiest to slit in July), or electrical tape.

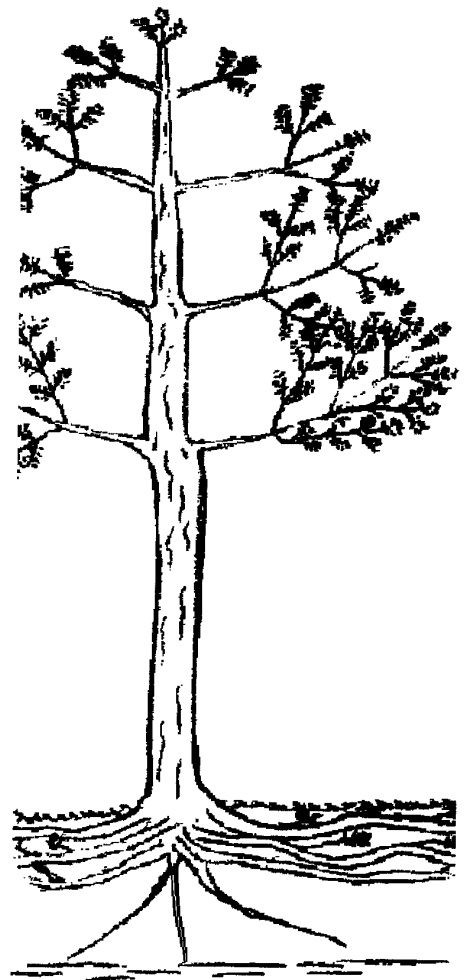
e. **Splint the scion and stock** against wind shaking between the top and bottom of the union.

f. Wrap the total splint to stock and most of scion with **white** plastic strips of polyethylene and intermittent friction ties upward on the scion to pull-in the scion needles and semi-seal them, except for small gaps and at the growing tip. Tie off with a friction ties, and loop of masking tape, top and bottom. A cap of aluminum foil with holes penetrated by a lead pencil can shade the top of the scion.

- g. Return in the third week to check things, remove aluminum foil, and clip off half the stock's candle (growing tip) above the union.
- h. Return at the end of the fourth week to remove the white tape to a slip tie down the scion, and loop that slip tie with masking tape.
- IV. Nut pines are useful in providing a wind break, and species mix to the nut grove. They moderate wind while the sun heats their needles generating a warm microclimate. The oils and resins they produce fight nearby insects, fungi, and bacteria. Avoid salt spray from roads onto pine any winter. Watch for damage to small pine trees. Bark borers, rodents, and deer can kill them. Small pines need to be sheltered by other trees. Sugar maples in pastures need years of sheltering in brush, especially crab apple. Pinyon and Utah junipers grow in a similar association at 3300 ft. to 8200 ft./ 1000 m. to 2500 m. in Nevada. Grow them into their eighth season, and things should be good thereafter on a deep gravel soil.

V. Future with nut pines:

- A. Nut pines are interesting because the South-West used to be a wet area 5,000 years ago. Even today single leaf pinion pine grows as a stunted midget at the top of an aspen grove where at the edge of a desert, but follows the aspens down to a bottom land where it grows quickly to be a giant like eastern white pine. The trouble is that it does not like eastern white pine sites in the East. Maybe if it were grafted on a compatible eastern pine sort it would prosper here. Maybe, if genome parts can be associated with tree parts, switching parts between close species can be figured out, and pinion can be given eastern roots.



BEECH, OAK, ALMOND AND EDIBLE LANDSCAPES

BEECH, NATIVE (*Fagus grandifolia*)

EUROPEAN (*Fagus sylvatica*)

SWEET ACORN OAK-SELECT WHITE OAK FAMILY TREES

WHITE (*Quercus alba*)

RED OAK (*Quercus rubra*)

SWAMP CHESTNUT (*Quercus michauxii*)

BUR (*Quercus macrocarpa*)

EUROPEAN WHITE (*Quercus robur*)

ALMOND (*Prunus amygdalus*)

SWEET KERNEL APRICOT (*Prunus armeniaca* var. "sweet")

CORNELIAN CHERRY DOGWOOD (*Cornus mas*)

JUNE BERRY (*Amelanchier alnifolia*, *A. canadensis*, *A. laevis*)

MULBERRY, RUSSIAN (*Morus alba*)

NATIVE (*Morus rubra*)

AUTUMN OLIVE (*Elaeagnus umbellata*)

JUJUBE (*Ziziphus jujube*)

GINKGO (*Ginkgo biloba*)

NANNYBERRY, WILD-RAISEN (*Viburnum lentago*)

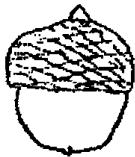
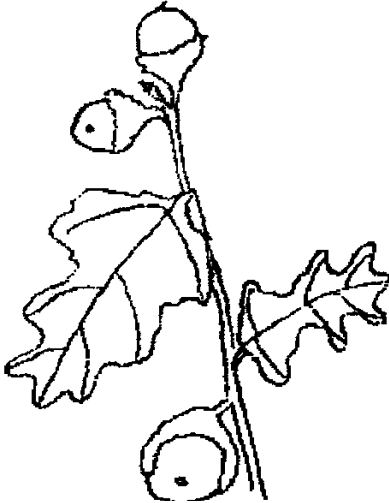
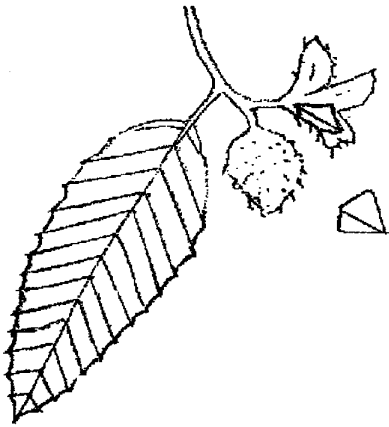
ELDERBERRY (*Sambucus canadensis*)

CHINQUAPIN (*Castanea pumila*)

1. Edible landscape is a label for these useful trees and bushes. Except for almond, they are used mostly in landscaping, conservation plantings, and agroforestry. They offer crops, and our work with them notes their high potential for food production, especially among selections. Very often we are growing beech, juneberry or mulberry in a forgotten corner without noticing. If cornelian cherry or autumn olive were native, they could be as widely distributed as beech or juneberry. If we live in peach growing regions, almond and sweet kernel apricot deserve some attention.

A. Beech and oaks are genetically close. Oak acorns are easier to grow. They can be sown in full sun. Beechnuts, like chinquapins, have little shelf life, and need immediate planting upon harvest to germinate as is necessary in the fall. White oaks also germinate in the fall, but can dry somewhat with little harm done, except late planting needs cutting of intertwined root. Beech transplants need partial shade. In the wild they root sucker to take over the forbiddingly acid, inorganic, rocky, or clay ground as long as it is a bit above the spring water table. Beech wood is hard to nail, warps/cracks upon drying. Logs usually become pallet lumber, hardwood stakes.

1. Oak acorns crop reliably, but not as reliably as chestnut, and like beech make a gluten free flour. Red oaks, and beech nuts are richest in oil. Beechnut used to be heavy cropping, if you believe reports from the early 1900's. White oaks bear annually, blooming every year, and carry maturing acorns for two years. White oak acorns extend roots in the fall. We have found "sweet white oak acorns" which are sweet, usually bland depending on the season, but not harsh with tannin pucker like red oak. Red oak tannin is more water soluble, thus yields more pucker with less tannin. Red oak is the better food source due to oil. Ask any deer or turkey.



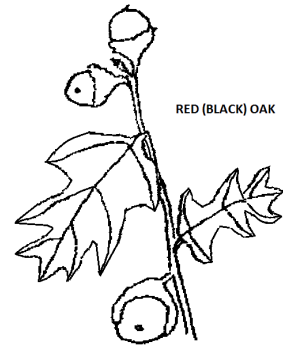
Red oak acorns leach more tannin overnight in warm water than white. Acorns are done leaching after water no longer turns brown on leaching. Red oak acorns (faster, fewer water changes, not needing hot water) leach to a firmer nut. White oak acorns almost turn to mush in hot water over-leaching. Thus, use red oak acorns to substitute for kidney beans in chili con carne, if you like more chewy, richer food. Red oak acorns have more oil, drying to shrink flexible to easily roll off their loose hulls (white oak acorns solidify, and stick to their hulls.) Red oak sometimes works as a chestnut rootstock, but is not worth the effort due to constant graft incompatibility problems. Red oaks have pointy cusped leaves. White oak leaves are round lobed.) Red oaks alternate crops every second year due to a two year bloom cycle. White oaks mature acorns each year due to bloom each year, and two years development-of-seed. Red oak acorns germination in the spring. White oak acorns germinate in the fall. Red oaks like acid/chestnuts ground. White oaks like bottom land and limestone soil. Oak, beech, and chestnut flour need to be refrigerated due to oil content. The Asian countries import white oak acorns for medical use. Do not graze cattle where acorns come down early and full of tannin. Most white oak acorns are consumed by wildlife due to early ripening, but grazing on white oak acorn comes second when more nutritious red oak acorns start dropping. European white oak is usually more productive, and have more ornamental landscape selections. White oak wood is dense, non-porous and crack resistant for lumber. Red oak wood is good for boards and paneling, but is porous, thus no good for boats/wine barrels. Fall transplants of white oak will desiccate due to leaves that are held nearly until spring, so start early, water, and clip leaves at end of growing season when transplanting. If fall dug, laying flat, covering roots with dirt and leaves with straw, allows root growth (recovery) in fall, then early spring transplanting restores a stronger renewal of growth.

1. Another acorn-like nut we have found growing in Ontario is the sweet/ bland horse chestnut (yellow buckeye), *Aesculus octandra*, introduced from the mountains of the Carolinas.

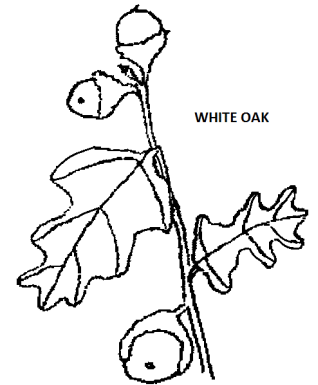
B. Hard shell almonds are grown productively in our peach climates. Almond trees resemble peach, benefits from the same culture, but have few northern selections. Two hard shell almonds, Hall's Hardy and Campbell's NC-1 (a Titan seedling) do well. Almondier rootstock is propagated by greenwood cuttings off a hundred year old hard shell almond growing in a wet limestone soil in France, Almondier is a favorite *prunus* rootstock in France and Italy. Hardy almond seedlings rarely have soft shells. Seedlings of hardy almond often have bitter kernels. Today we have little seed to propagate, and there is little optimism due to our many *Prunus* viruses. Almond has the ability to self pollinate which means that crossing selections is often done by emasculation and hand pollination. Once a selection is decided upon, green wood shoots are propagated as cuttings. Almond and apricot seed should be slightly dried, then held under cold moist stratification in August, planting seed in early spring. These germinate promptly in warming soil. Successful transplanting is also aided by cold storage. Once almond or peach starts to leaf out, they are easily killed after transplanting by freezing. They should be the first trees dug in spring and immediately moved to cold storage then delay planting out. Hammers or vice grip pliers are needed to crack hard shell almonds, although sweet kernel apricots yield to lobster claw crackers.

1. Sweet kernel apricots (also called alpricots) will hand crack like filberts. Grafted trees like Stark's Sweetheart, and the variety reliable have sweet kernels as well as good fruit. Apricots self pollinate so Ernie Grimo has been emasculating and crossing Vineland and Harrow selections. Many crosses revert to bitter kernels. Work with them is hampered by our many *prunus* viruses. However, Doug

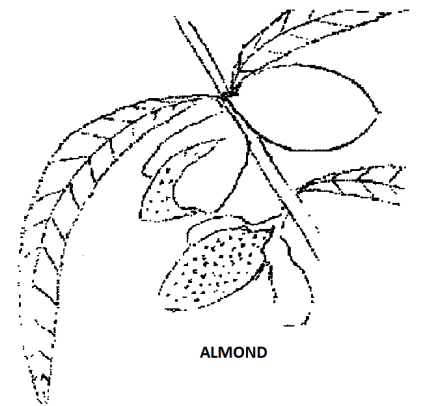
Campbell finds that Reliable apricot seed/strain produce hardy,



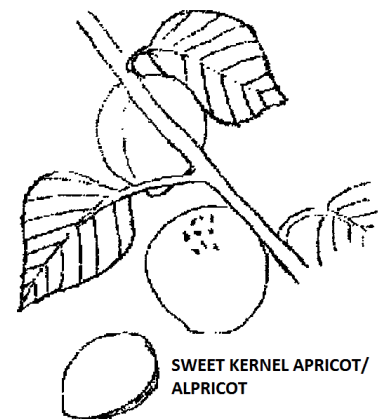
RED (BLACK) OAK



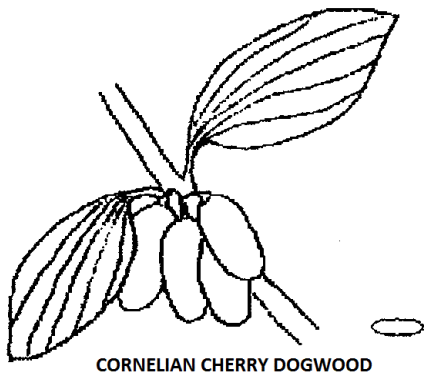
WHITE OAK



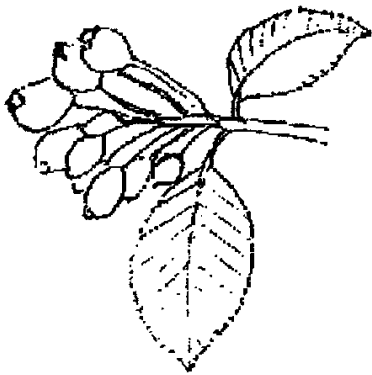
ALMOND



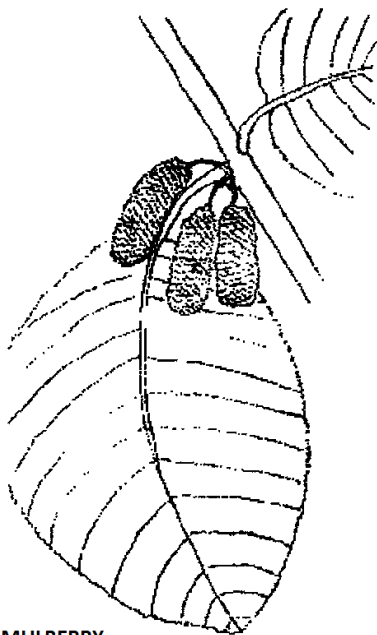
SWEET KERNEL APRICOT/
ALPRICOT



CORNELIAN CHERRY DOGWOOD



JUNEBERRY/SASKATOON/SERVICEBERRY/
AMELANCHIER



MULBERRY

and sweet kernel seedlings. Apricots need the growing conditions, and the culture of peaches. The soil needs to be richer, darker, built up with organic mulch much more than peach soil. Apricot rewards the effort by being hardier to deep winter cold, resistant to frost after embryos have formed. Spring bloom is, like almond, often nipped by a late frost, but formed embryos can tolerate some freezing. Alpricots are duel crop; fruits and nuts. Squirrels harvest the nuts, pits, early, and dump the fruit.

C. Cornelian cherry dogwood is a hardy ornamental bush. It thrives on limestone break-down soil of the escarpment in Niagara. As a hedge or border bush you will see its mist of pale yellow flowers, first to bloom in March, and oblivious to deep cold. Crops never fail. The small olive-pit-like seeds (each with two embryos) are hard and remain dormant for years. They accumulate under the bushes with only a few nibbled by mice. You can gather them and plant to have some of the mix germinate in spring, then again the next spring. Glossy green leaves start after bloom. The long fruit turns red in August and sour-cherry-like in September. Birds are not attracted. The bush is minimum care, forms a semi-hedge, and transplants easily. Our very tart fruits are said to be poor compared to European selections, but with quince make a great jelly. The selection Blackplum has fruit of Japanese plum flavor (if ripened fruit is stored for a day), never insect damaged. It has dark red fall foliage. Cherry dogwood has to be the first tree grafted in spring, with chestnut and filbert. Do grafting extra early, and chance frost. Putting off grafting suffers runting-out due to heat onset. See plastic bag graft p. 41.

D. Juneberry blooms in early spring with white (sometimes pinkish or yellowish) clouds of flowers. They bear 1/4 in. to 3/8in./ 1 cm. blueberries; relatively larger seeds, sort of soft apple/blueberry taste, often robin harvested. Juneberry is cultured like filbert, as a bush, or a tree. They like apple ground, and range into acid ground. Their vigor and ornamentality doubles with an organic mulch. They transplant easily although they lack substantial roots. They have to be forced to single tree form as do filbert, cherry dogwood, and autumn olive. Juneberries usually grow with minimum care. Fire blight is a problem if juneberry is kept growing late in the season by over-doing nitrogen fertilizer. The seeds should be cold moist stratified.

E. Mulberry grows to be a large tree like standard apple although most large mulberry are center hollow, usually do to some low injury. Hardy Russian root stock helps avoid trunk injury. Root stocks usually show orange bark, or Teflon at the graft union to make the graft visible. Immature trees have three lobed leaves like fig. Mature trees have broad, heart shape leaves like catalpa, especially flossy native red mulberry leaves. Injury near the ground can be traced to south-west injury, rabbit chewing, ice flow injury, not painting or hilling transplants. Like pecan mature mulberry is not hardy near the ground until the bark is corky and rough furrowed. Mounded earth applied to the grafts carries most low grafts through winter, as do white latex paint, and good summer growth. Illinois Everbearing, Collier, Mud River, and Wellington are purple northern mulberries often found in catalogs. Illinois Everbearing is hardiest, has berry flavor of large, blackberry fruit which ripens over a long season, late June to early August. Bird problems abound; eating pooping, staining. Seed handling involves washing, drying and cold moist stratifying, if not immediately germinated after harvest. Illinois Everbearing is seed sterile, and must be propagated by grafting on hardy rootstocks. Many hardy mulberries will propagate by sticking dormant cuttings in spring. Illinois Everbearing is difficult to root so try the trick used with elderberries and blueberries. Gather **fall** cuttings: stick in IBA and tap off, wax top ends, bundle, paint the cut bottom with Elmer's glue, stick the bundles vertical to the ground where the grounded tips will not freeze (top ends fluctuate with moderated day/night temperature); then stick as normal cuttings in spring (in tube shelters). This is said to work with pecans in growth chambers, but pecans need take two winters.

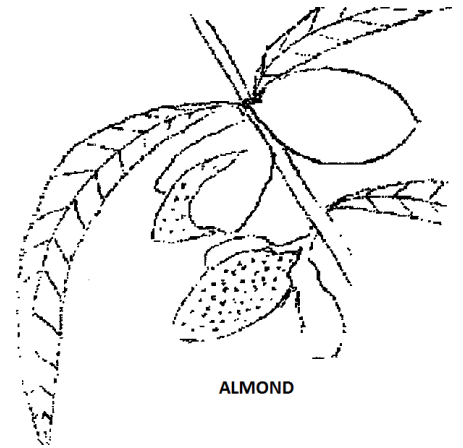
1. I once found an elderberry that tasted like a blueberry that I should have propagated in bundles set through winter. Returning to propagate it yielded only the mellifluous elderberry taste of unripe mulberry. Elderberries have debilitating virus problems, so propagate a good bush when you find it, and keep propagating with fall cuttings to save some from virus.

F. Autumn olive is the grey-green bush used to border road rights-of-ways to trap snow. In mid-September autumn olive becomes brown-red with dense clusters of centimeter long, orange berries. So why is my best autumn olive yellow? The berries of autumn olive are much like red current berries, except more solid and sweet-citrus-fruity. Sectors of the bush die from virus, or winter injury, but the bush usually recovers. Autumn olive fixes nitrogen. It grows best on a well limed sandy soil where it fixes nitrogen. Transplanting is easy, and aftercare is minimal except for the constant need to trim back the large, thorny-like-plum, floppy-like-viburnum bushes. Berries will strip mechanically. The berries can be used for juice, eating out-of-hand, and tart topping. The berries have good shelf life for shipping so I keep expecting to see them in stores, or on farmer's stands, where I contribute some of the sweeter yellow sort.

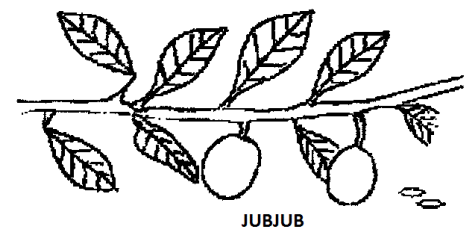
G. Jujube is a desert tree from northwest China which suffers in Ontario. Jujubes ripen to be a punky-date that needs its dry flesh filled out by soaking in a sugary syrup. Away from the Lake Shore jujubes need a warm, less fluctuating summer. They lose fall fruit to cold, small limbs to winter cold, and grow very slowly. They flower in July-August with small fragrant whitish flowers. Branchlets are thorny like black locust. Leaves are small and glossy dark green. The roots send many suckers, which make a seedling selection easy to propagate. They grow better in mid-Indiana.

H. Ginkgo is a strange nut. This same tree is older than the dinosaurs, and ginkgoes are much like the dinosaur-food pines. Female trees have nuts with oil in their fleshy hulls which putrefies like rancid butter, giving pause to going after ginkgo, but coyotes eat them. Kernels are sour cherry size, and shell like apricot size seed pistachio. The kernel is two part; the outer sack that is like doughy nut pine kernel, and a fluid center that is a milk-like-sweet chalk. This milk is the likely the reason the nuts are dead at first freeze. Drying while roasting sweetens, and firms the kernel, but only partially dries and sweetens the fluid. A yogurt taste is left; not what one expects from a nut. And yet, where the tree is native, in China, it is accepted as a very edible nut. As a health food ginkgo turns body chemistry basic, and less cancer hospitable than hazel, which adds body acid. Nuts need quick harvesting before ever freezing, cool stratifying, and planting in rich garden soil.

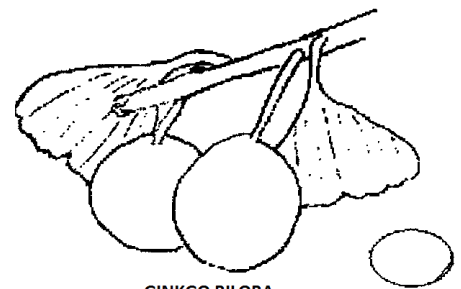
II. Is there a future for these fruits and nuts? A nut as useful and popular as almond has to have a future. Almonds are a high value import. Local growers are going to have trouble producing high quality almonds. Juneberry has the appeal of blueberry, ripening in an earlier fruit starved season. Autumn olive is an early to late fall crop. All these fruits and nuts have some future. They continue. Oak acorns, juneberry, almond, sweet kernel apricot, cornelian cherry, mulberry, and autumn olive have useful fruit over a long season, late June to October.



ALMOND



JUBJUB



GINKGO BILOBA

PERSIMMON

NATIVE PERSIMMON (*Diospyros virginiana*)

ORIENTAL PERSIMMON (*Diospyros kaki*)

I. Few persimmon cultivars produce quality fruit in Ontario/NY. Persimmons are native to Ontario along Lake Erie, and near Syracuse, NY. These are the 90 chromosome race from the mid-western states, and **not** the East Coast 60 chromosome race which lacks bark hardiness and good selections. The mid-west has many seedlings and selection to select from because trees are as hardy as black walnuts, and any tree with fruit that colors up will ripen up even after frost, so just save persimmons which color early/have early pollen, for selection. Persimmons are heat loving trees which stall in grafting, growing, or ripening while heat is low, 50s°F/10°C. Trees load with fruit so a grower needs to become expert at wine or ice cream making to use the crop. The paste made from persimmons can be cut with water several times, and remain a thickener, or fluid gel. Persimmon has a harsh aftertaste. I sell seed, and eat many persimmons in the process, but only clean 25 persimmons without satiation (20 are joy, the 5 more are okay, but the last leaves enough harsh aftertaste that I could not endure field seed cleaning without the cleansing of palate by a pawpaw.) It takes an Ice cream favored pawpaw to cancel the harsh aftertaste of an in field (just ripened) persimmon. Deer eat fruit with color left on the ground.

A. Most named persimmons originate from Western Pennsylvania to Iowa. Some people consider Early Golden, cultivar discovered near St. Louis, a standard for earliness and non-puckery fruit. It fails to color/ripen properly in Niagara except in warm, above average seasons. In a cool season usually only Dickie, NC-10, Yates, and Geneva Long ripen full crops. Persimmon blooms late enough for bloom to escape late spring frost, however frost injury to foliage is often a spreader of persimmon black spot on foliage and fruit. Geneva Long is the most commercial, completing the season large, firm, ripe; the best at ripening in-doors. All benefit from days after-ripening indoors. Geneva Red is high flavor late-ripe persimmon.

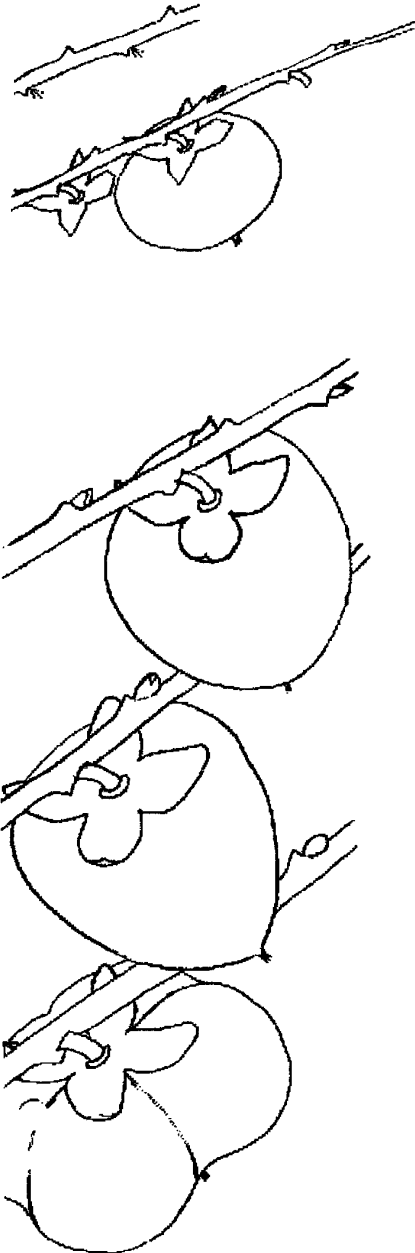
B. In a cooler than normal season, persimmons are slow to color and lose their puckery aftertaste (tannin as in acorns, which protects against insects, but not crows). Despite the aftertaste, most people would say a persimmon is ripe if eating one encourages the eating of another. This complicates the taste testing of persimmons due to the degrading of smell sense, and taste buds by the puckery aftertaste of the first sample. The first rule of persimmon eating is: **Break the skin, and smell. If the smell is not fruity/honeyed, don't taste it.** If your goal is to select persimmons for early ripening and taste, take along someone who does smelling, and saves his sense of smell by not tasting. Each variety needs a taste test to select the ripe color, ripe texture, and ripe calix darkening. Even oriental persimmon in the field leaves a harsh aftertaste. It is a slight defect usually mitigated by eating another, a bit of ice cream, or a pawpaw that leaves its soothing aftertaste.

C. Persimmons are too soft to ship, or stack, and injure if dropped on hard ground. In China oriental persimmons are gathered in stringers of branches, and ripened on the stringers, or in cells of egg cartons. Slate's Geneva Long ripens off the tree, so clip stems, and store in egg cartons.

D. Native persimmon trees can suffer south-west bark injury on their trunks at one foot/ 30 cm. depending how high the snow, how strong the sun, and how deep the cold in shade. Oriental trees die at the first fall frost because they need a 180 day season, not our 160 day season.

E. Like melons, both persimmons and pawpaws are instantly enjoyed by people who have never before tasted them.

1. The typical astringent aftertaste of native persimmon can be eliminated by curing. **Once colored yellow and softening**, they will ripen on the tree through warm periods following a freeze. Also, persimmons with pucker aftertaste can be brought to full ripeness by overnight storage at room temperature. Harvesting native persimmons has to wait for the fruit to fully color, or begin to soften, for heat ripening



to be effective indoors. Orientals and Geneva Long persimmons will ripen with heat after yellowing. Professor George Slate at Geneva, NY Ag. Test Station bread between oriental and native persimmon, trying to secure the 160 days to full coloring as is necessary. Unfortunately, crossing is easily masked by the species influence of the female parent due to the redundancy of 90 chromosomes forming up under the pressures of the female chemistry.

2. Another curing method for persimmon is to allow the fruit to raisin on the tree. Although the fruit has difficulty fall drying in our climate, once it accumulates some color and some sugar, freezing will remove astringency with no freeze injury, but the fruit needs Indian Summer to gain more sugar, and ripen to quality, then dry to form a date.

a. Freeze drying can take over and cure the persimmon. The fruit should be shaken from the tree while frozen, and bagged for freezer storage. Frozen persimmons, which ripen in the warm growing season, retain their shape, sugar and color. A few cycles of freezing and thawing will start to darken them, starting the date flavor. Eating persimmons direct from the freezer is much like eating a persimmon popsicle. It is hard to think of a 4 cm, or 5 cm. diameter frozen persimmons as a marketable item unless you are eating one fresh off the tree. Morris Burton persimmon (which ripens partial crop under Ontario conditions) retains its persimmon flavor in freezing, and baking far better than other cultivars, likewise after its pulp is sieved and frozen. Persimmon pulp is a marketable item used in ice cream. Morris Burton has seedlings much like itself (Geneva Red types, MB1, etc.) which present the unique Morris Burton flavor, and completely ripen on the tree most seasons.

II. Several native persimmons matured their fruit locally, even during recent short cool seasons.

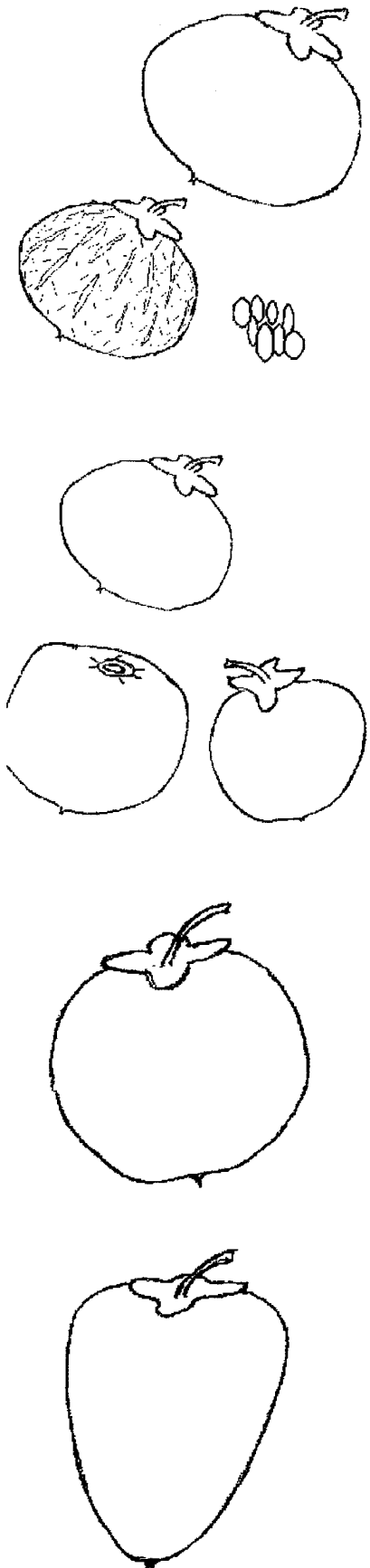
A. Pieper persimmon produces ripe fruit even though it overbears like fruit trees, and should be thinned. It is worrying to see Pieper going into winter loaded with ripening fruit. Such treatment is known to injure trees, but Pieper from Iowa returns to bloom with no sign of winter injury. Its foliage becomes ornamentally yellow in October before frost. A seedling of Pieper, SAA Pieper, is Pieper again with ripe fruit in early November, and the same small-egg-size fruit.

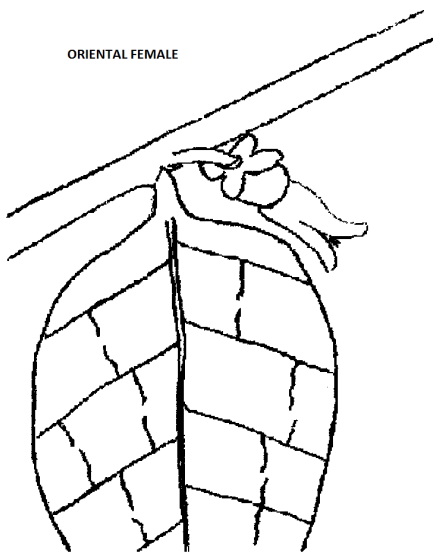
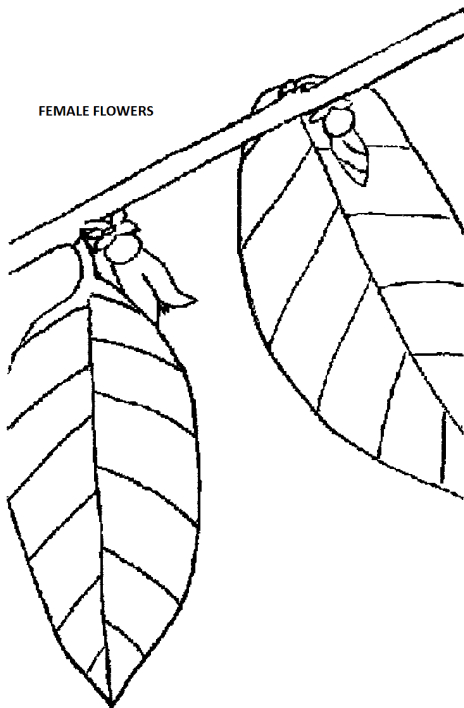
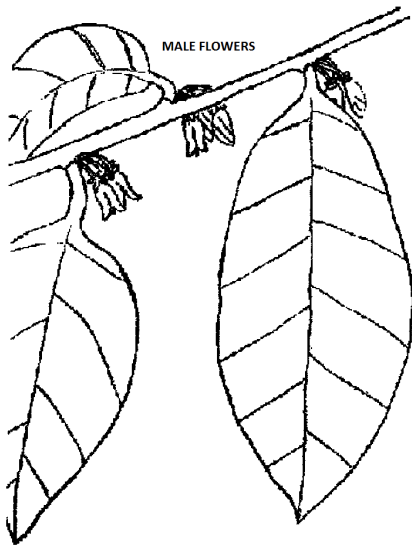
B. Richards from Kentucky, and Meader from New Hampshire are mysteries to us (Meader and Early Golden seldom ripened here.) Meader is a seedling from Prof. Sate's seed which bore seedless fruit as an isolated (only seedling to survive) persimmon near Rochester, NH. The explanation about the "seedless" Meader is simple enough in that local chestnut pollen sets seedless persimmon fruit, and Meader has had seed here. The description which came with them said they were extra early ripening and high quality. Richards ripens extremely soft fruit. Richards ripened as early as any in the long hot summer of 1991, but proved to be too soft, and semi-seedless. It is good eaten off the tree in late September, but a long drop on leaves does not give enough padding for good fruit, and quick eating of mush will extract few seeds.

C. Yates is a winner. A seedling twin of it is earlier. It is from the hills of southern Indiana. It ripens large, Japanese-plum-size fruit, sometimes in mid September. When smelling ripe, Yates is fully ripe without astringency. The astringency, and ripening over a long season

have been faults of NC-10 persimmon. However, in

PERSIMMON 112 exceptional 1991 NC-10 started ripening in August free





of astringency. NC-10, Yates, Szukis, and Hess (from Iowa) have the best foliage, lustrous, leathery, dark green from early June until October (unless frosted in May to causes black spot on leaves). Other selections have lighter green foliage which is marked with black streaking/spots. Hess has a long fruit, large, identical to Geneva Long, but too late ripening most years (exceptions; hot 1991, 2006, 2010.)

D. Geneva Long is unusual because its fruit looks and tastes like a semi-oriental persimmon. It is the only native persimmon that can be recommended for fruit stand sales because it retains texture after ripe for about a week. Even yellow-green, Geneva Long has a not-too-astringent a fruit. It is mid October ripening. The fruit retains texture so it can be sectioned like a tomato to be put in a salad/desert.

E. Szukis (pronounced Sue kiss) is a bi-sexual persimmon which yields early pollen and fruit. It is early ripe like Yates, and its fruit size ranges from small egg like Pieper and NC-10 to almost the large egg size of Yates. Because you need one male tree to produce good persimmons (seeded fruit are 20% larger), Szukis gives early pollen plus produces some good fruit, though production dwindles as more of the tree changes to male. Other persimmon trees (except oriental) are typically totally male, producing only pollen, or totally female, producing only fruit, except for a small fruit from stray queen pollen flower, or stray branchlets of pollen on female trees.

1. Seedless persimmons mature before persimmon fruit with seeds. Because they often have poor flavor it is easy to think of them as degrading while aborting rather than truly ripening. Pieper, NC-10, and Evelyn (another Prof. Slate seedling grown by his secretary, Evelyn) often produce seedless fruit. Persimmons with no seeds ripen before fruit with one or two ripe seeds (8 seeds is the full set). Seedless persimmons are smaller than the same variety's fruit with seeds, so it is possible to find seeds from Evelyn by gathering the few largest fruit. A persimmon fruit is a remedy for gerd/acid reflux, like 3 almonds are.

a. Early ripening persimmons bloom early. Farther south any male tree will pollinate an orchard. Ontario/NY needs male trees with extra early bloom to get bees gathering persimmon nectar before the females come into bloom, or we lose the earliest part of our crop. Early flowering males are as scarce as our early flowering females. Fruit on flowers that are first to bloom will be weeks ahead in ripening due to the heat send-off they get in mid June.

2. Persimmons are insect pollinated. They are nectar trees. Male flowers are 3/8 in./7 cm. long and born in groups of three, most with no detectable ovary. The male flower stems remain attached to the tree, allowing sex determination of a tree during winter. Both male and female blooms are white, bell-shaped flowers born at the leaf axils of new wood. Female flowers are 5/8 in./1.5 cm. long with a discernible fruit ovary between flower petals and fruit stem. Female flowers are born singly. The flowers stem and calyx may remain on the tree during winter indicating that the fruit ripened on the tree. The size of the stem and calyx gives an idea of the size of the fruit.

III. Cultural practices which aid early ripening:

A. Plant trees in a cove location where they get plenty of sun and very little wind.

B. Produce a warm soil. Use drain tile, clean cultivation, a south exposure, warm water trickle irrigation, and no nitrogen into fall.

C. Intercrop with black walnut. In Geneva, NY where Evelyn persimmon grows in a walnut grove it is two weeks earlier than where it grows in the open. Anecdotal information on persimmon intercropped with black walnut is accumulating. The warmer microclimate set up by black walnut is benefited by wind reduction, light through an open foliage, deep roots drawing up moisture, but persimmon

will not like walnut increasing soil pH, so this may call for more acidification.

a. Benefits to black walnut from persimmon intercropping can be wind reduction, a denser planting which forces walnut to grow tall, and less grass with increased culture and fertilization needed to produce persimmon crops. Persimmons grow slower than walnut especially when they start cropping.

b. Fertilizer requirements of persimmons, similar to apple, will be about 1000 lb./500 kg per acre of 15-15-15 granular fertilizer split broadcast in early spring/in late spring/in mid summer. Applying too much nitrogen to persimmons during the growing season may shock them. Persimmons may drop crop and leaves if heavily fed in the late growing season, and cause winter injury.

IV. Persimmon wood is very hard, crack resistant with interlocking grain, and polishes as it wears. Golf club heads and weaving shuttles are worked from persimmon wood. I have cut 6 in./15 cm. persimmon trees and seen no black center wood, but seen black weaving shuttles. Persimmon is the most northern member of the ebony family. The black must be iron staining as in persimmon cooking with iron implements. Even touching with base iron stains pulp black.

V. Propagation of persimmons is by grafting, seed, root sprouts, and root cuttings. When digging, cut the tree end of the root square, lower end of the root slant, to record the slant end to plant deep. Air layering and rooting of greenwood cuttings has **not** been successful.

A. Persimmons are easy to germinate. Seed will sprout which has lain outside through the winter. Blue jays, chipmunks, and red squirrels eat persimmon seed.

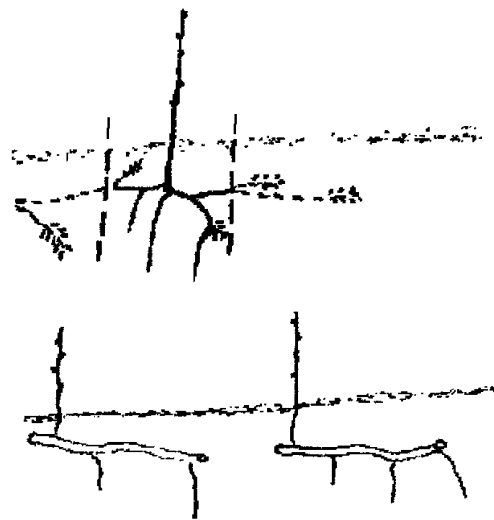
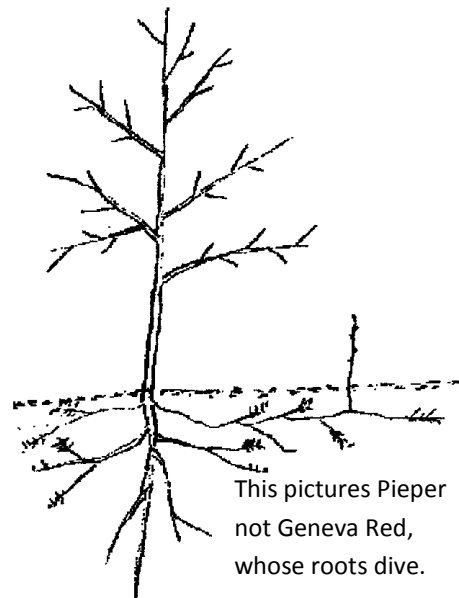
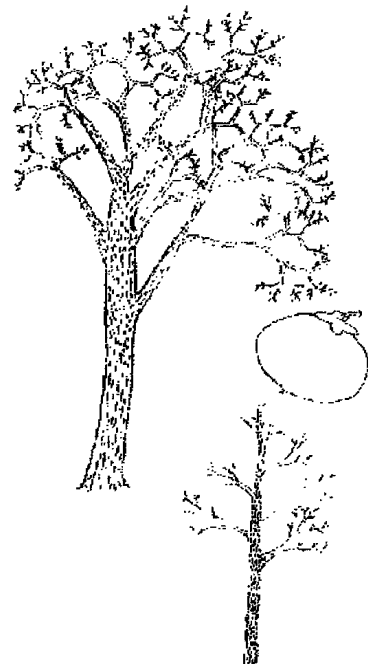
1. Persimmons from seed:

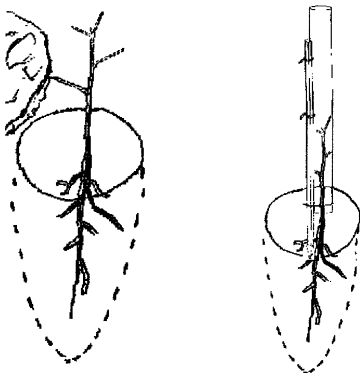
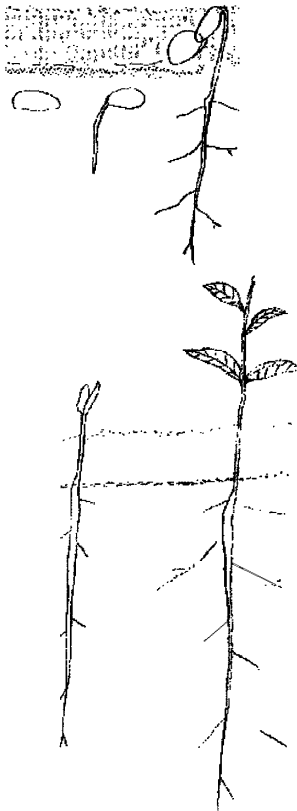
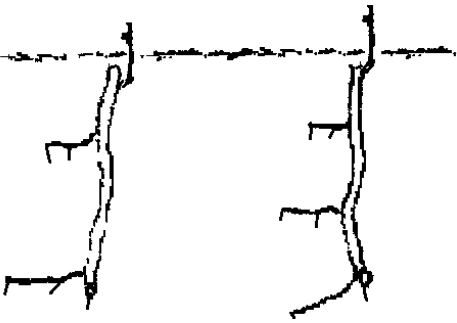
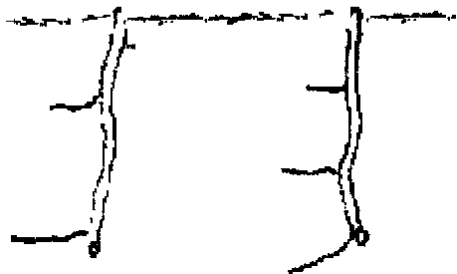
a. Gather persimmon seed after it has turned dark brown. Seed turns from greenish yellow to brown as the fruit softens. For ease of storage remove the pulp, wash the seed and allow it to air dry for two days or less. I have had to freeze persimmon seed to 30°F/-1°C seed in a plastic bag with damp peat moss to keep it from molding though a friend recently put me onto a citrus fungicide. This does not seem to be as big a problem farther south where persimmon seed is riper, and the hull is thicker.

b. Fall sow persimmon seed by covering with 1 in./3 cm. of dark earth, and 1 in./3 cm. of hardwood sawdust. Spring sow persimmon seed after the ground loses moisture, and can be worked. Cover the seed with 1 in./3 cm. of dark earth. If the weather is dry, water the planting heavily at weekly intervals, or germinating persimmon seeds get trapped in the soil crust.

c. Fall planted persimmons can grow 1 ft./30 cm. the first season and 1 meter the second, but spring planted seed grows half height, but in thicker stands. Before persimmon seed breaks earth spray Roundup + simazine herbicide to keep down weeds. Lay down two layers of orange diamond plastic construction safety fence. Bait with orchard mouse bait.

d. Transplant persimmons by the beginning of the third growing season. Persimmons which are dug with complete and uninjured root





systems can be transplanted early into cold ground. Unfortunately, persimmons have a combination of deep tap roots and long surface roots, or even a lightning strike root pattern that easily breaks before gotten out of the ground. Digging these uninjured is difficult. Delay digging until the buds begin to swell and hold the bare root persimmon in a cool, full shade location until the ground warms. Seal the roots in a plastic garbage bag filled with moist sheets of newspaper. Cover plastic with earth.

e. Spray a 7 foot/ 2 m. spot where the transplant goes with Roundup + simazine; wait half a day for weed absorption before digging. Dig a planting hole larger than the root system to be planted. Persimmons like a dark, warm soil. A well drained soil is necessary to increase roots on a deep soil site. A dry site will be warmer, more persimmon friendly. Mix the replant soil with a cup of bone meal. Spread the roots while refilling the hole with soil. Tamp the soil around the roots while tugging on the tree to keep the roots extended. Rod the soil between roots with a stick, or shovel handle. Add enough water to the soil to aid consolidation, but less water than will turn the soil to mud. Persimmons grow best when liberally watered with warm water as supplied by drip flow from a hose in the sun. Persimmons do not repair their roots until their tops sustain growth. Like chestnuts, persimmon transplants can grow rampantly in hot moist weather although their injured roots don't sustain this growth in drought, and drying winds. Water with acidified water to keep ground moist because upon wilting, persimmon leaves fall off. When growth is renewed, it may come too late in the season, and may not save the top from winter injury.

f. Plastic tree tube shelters are almost essential. Stake a tree tube shelter over the tree, tapping it into the ground a few centimeters so that mice do not enter, and cut the shelter to 6 in./15 cm. above the transplant.

(1) Alternatively, stake the transplant with a 6 in./15 cm. tube of octagonal plastic garden fence, inserting the coil 2 in./4 cm. into the soil. This tube should ward off rabbits, woodchucks, and antler rubbing deer.

(2) Trim back dead branches, and coat Elmer's glue to the surface of bark wounds.

(3) Water as often as is necessary to keep the soil from drying out. Water deep using 5 gal./20 l. plastic pails. Treat well water with agricultural sulfuric acid.

g. Apply 15-15-15 granular fertilizer 2 lb./1 kg. per 1 in./2.5 cm. of trunk diameter broadcasting away from the trunk to past the branch spread.

h. After the transplanted persimmon starts growth spray Roundup + simazine to grass and weeds as they are out 6 in./15 cm.

i. Fertilize persimmons with 15-15-15 granular garden fertilizer same rate, 2 lb./1 kg. for each 1 in./2.5 cm. of trunk diameter each 2 months of the growing season each year while trees are small. Soak in with the last snow in March. Broadcast the fertilizer from the trunk toward to past the outer branches. Keep the fertilizer 10 cm. from the trunk, minimum. Any pellets contacting the trunk should be removed before they burn the bark.

j. The general rule is to plant as far apart as you see mature persimmons tall. Mature spacing could be 34 ft. by 34 ft./10 m. by 10 m. (,filbert spacing) for Pieper, or 50 ft. by 50 ft. (chestnut spacing) for Geneva Red/Prok/Yates. Summer prune to keep fruit trees small and productive. Train a short tree with five main branches that go out like a spiral stair around the central leader.

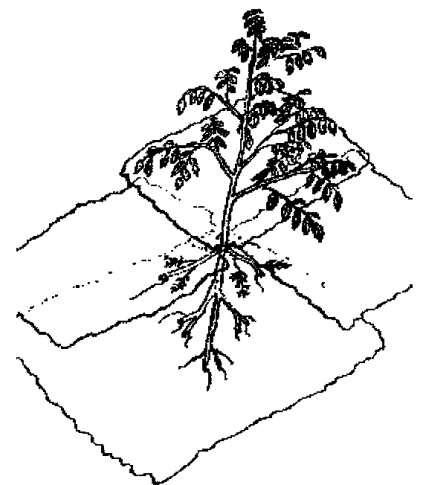
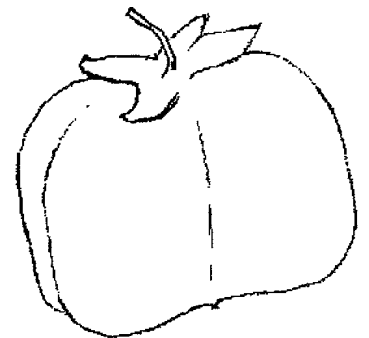
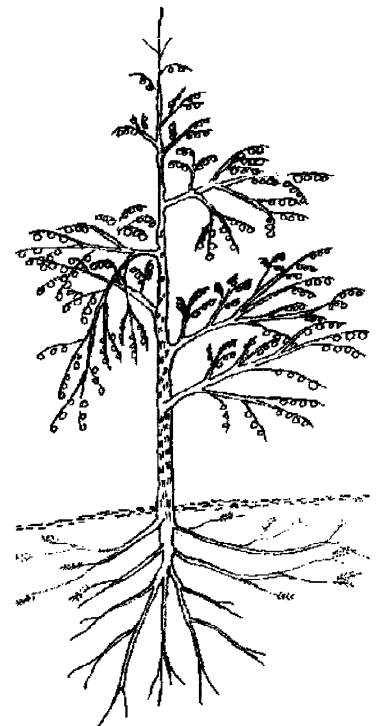
B. Persimmons are unusual because they drop (prune) twigs as well as leaves. As the trees go dormant their leaves turn yellow tinged with pink. The leaves fall after a hard frost. The yellow fruit can remain ornamentally on the tree. In spring the small twigs release from the tree. This is natural pruning. Persimmons are born on new wood. Dropping of the twigs which have fruited may be part natural process by which persimmons mature and raise their fruit. Oriental persimmons are harvested in their native lands by severing the fruiting twigs and weaving them into garlands for curing fruit, and moving to market. Any persimmon limbs which grow tight upright against the leader (weak crotches) have to be pruned off.

VI. Oriental persimmons have survived for many seasons at Queenston, Ontario above the ice free water of the Niagara River. Sheng remained the longest, and succumbed from crowding. The trees were grafted in place on terminals at least one meter above the ground. Sheng fruited successfully after $-4^{\circ}\text{F}/-20^{\circ}\text{C}$, but Peiping and Great Wall died. Other orientals are said to fruit on Pelee Island in Lake Erie where they have the 180 day/Chinese season.

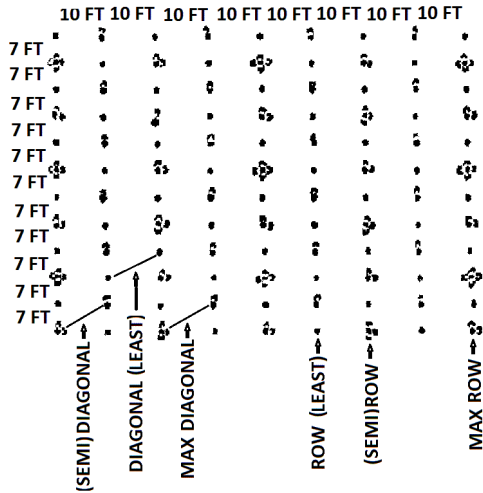
VII. Dormant grafting of persimmons in mid May follows filbert, chestnut, and pawpaw grafting. Be sure to top work on a thick, winter hardy stock. Try to graft 4 ft./1.2 m. high off the ground with the thickest scions available.

A. Grafting one's own persimmons is advisable to bring you within a year or two of fruiting the newest selections. First, you need to grow large stocks to insure they are hardy. Like in selecting hardy Persian walnut seedlings, persimmons seedlings can succumb in a test winter, which is cold and clear, if they are southern sorts.

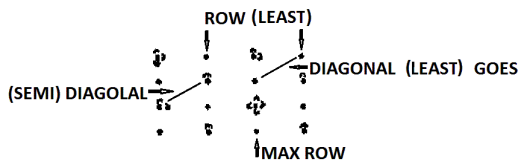
VIII. Transplanting needs trimming off of dead and injured roots. Persimmon roots are black, some black to the core. Which roots are dead and which are healthy is a matter of smell and texture. The soil must be kept moist and warm through the summer. Like chestnut, persimmon will extend lush new growth although its roots are poor and unhealed. Well water has to be modified to be acid. The grower mistakes this growth for a successful transplant, and ends watering too soon. New shoots droop, and the leaves fall. Re-applying water will start new sprouting though our season is not long enough to sustain the top over winter. If the grafted portion of this transplant succumbs, the new growth may be the seedling stock, the root stock



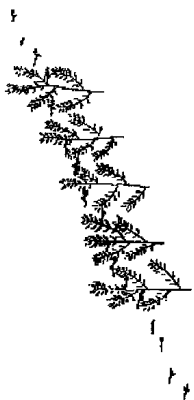
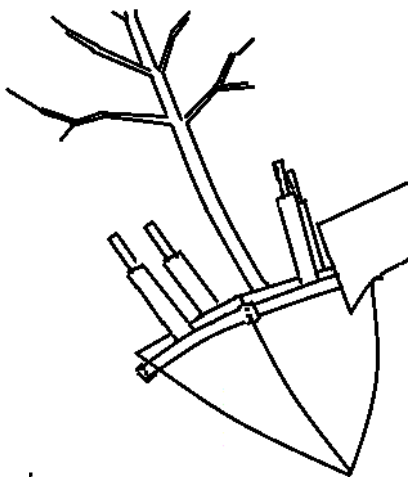
PERSIMM' ORCHARD SPACING FOR THINNING TO 40 BY 28
1120 SQ FT PER BLOCK
-AT STRESS-
LOG BUTT COVER LIMIT= .069 % FRT / .138 % TIMBER



16 PERSIMM' TREES ARE THINNED TO ONE TREE,
 1 TREE ON 1120 SQ FT/ 40 FT BY 28 FT.



- 1ST THIN REMOVES DIAGONAL (LEAST) 8 TREES GO
 - 2ND THIN REMOVES ROW (LEAST) 4 TREES GO
 - 3RD THIN REMOVES (SEMI) DIAGONAL 2 TREES GO
 - 4TH THIN REMOVES (SEMI) ROW 1 TREE GOES
 - MAX ROW BECAME PERMANENT 1 TREE STAYS
- $\frac{1}{16}$



sprouting from ground level the next spring. A clear polyethylene film ground cover could be used around newly transplanted persimmons to warm the soil and keep in moisture. Black plastic film could help smother weeds, but does not warm the soil as deep as clear. In drought maintain watering even though the growth seems adequate. Remove the plastic mulch in July when all the soil should be warmed.

IX. Persimmons are used in many recipes. The North American Fruit Explorers have published a persimmon book which contains growing and cooking information. Persimmon bread, cake, pudding, leather, etc. are set down. The essential piece of advise is to never use an iron knife, pot or pan in contact with persimmon. Use stainless steel, or aluminum because base iron stains the yellow-orange of persimmon pulp to black.

X. The thinning block is constructed from several spacing factors: tractor and equipment free movement, blocking west wind to warm orchard, contain 16 trees, but thin to 1 as trees mature. The maximum diameter of a productive persimmon tree is determined to be 12 in./30 cm., butt ratio yields 1120 sq. ft. per block, or 39 trees per acre. This is not timber for persimmon for timber would be 24 inches diameter/60 cm. We space trees closer in north-south rows to help moderate west wind, speed application of pesticides, and ease machine travel, and intercropping between rows. Current recommendation is to plant persimmon trees to a maximum height of 25 to 35 feet, thus select trees to be on 25 to 35 feet on centers. Interspace with seedlings, or alternate with seedlings and intercrop. Expect to move selections after observing, by using tree spades.

FILBERT/HAZEL / PERSIMMON/ PAWPAW/C mas / APRICOT / ALMOND	BLOCK FT X FT	LAND AREA SQ FT	NUT TREE THIN DIAMETER,		TIMBER TREE THIN DIAMETER,	
			"START DENSITY" AT 30 SQ FT/Ac LIMIT	"END DENSITY" AT 60 SQ FT/Ac LIMIT	"START DENSITY" AT 30 SQ FT/Ac LIMIT	"END DENSITY" AT 60 SQ FT/Ac LIMIT
			CM	INCH	CM	INCH
1ST THIN	10 X 7	70	7.6	3.0	10.7	4.2
2ND THIN	20 X 14	280	15.0	5.9	21.3	8.4
3RD THIN	30 X 21	630	22.6	8.9	33.5	13.2
4TH THIN	40 X 28	1120	30.2	11.9	42.7	16.8

XI. Farther north breeding of Persimmon is needed. You likely have no persimmon tree near by so breeding is your breeding with isolated females (bees can carry persimmon pollen for miles). The Morris Burton line of persimmons is unique and was brought forward a generation by Prof. Slate with the Geneva Red, and Evelyn selections. I collected pounds of seed of Geneva Red (Evelyn has few seed.) MB2 and MB3 are seedlings here, again a very red fruit, and a very ornamental sort. I also have Geneva Long on its own roots, and several good GL seedlings. These seed lines are easy to recognize in the next generation of fruit. Szukis has the earliest pollen so will likely to be carried on. Saving seedlings with the earliest flowers, keeping the early pollen males (many Szukis derived), and very early fruit, should maintain these, and NC-10/Dickie lines.

PAWPAW (*Asimina triloba*)

PAPAW, PAW PAW, CUSTARD APPLE, INDIANA BANANA

I. Pawpaw is a native fruit of Ontario which grow along the shore of Lake Erie, and the Niagara Escarpment to Rochester, NY. Most pawpaws are tropical fruits which leads to confusion. Our native pawpaw only tastes like a tropical fruit. It grows farther north than persimmon, is more hardy, and ripens more reliably. Sower sop (*Annona sericea*), its Mexico/Guatemala cousin, has the same small tree, and the same cancer fighting bitter chemicals in its twigs, but is too tropical to be a breeding partner.

A. Pawpaws are a concentrate carbohydrate food, tasting much like vanilla ice cream, or custard. Aftertaste is mango flavor.

B. People who crave tropical fruit enjoy pawpaw. They find European fruit too watery and bland.

C. Pawpaws start ripening in early September. A succession of cultivars can produce fruit through heavy fall frost, some ripening after being frozen, but this needs a nice Indian Summer.

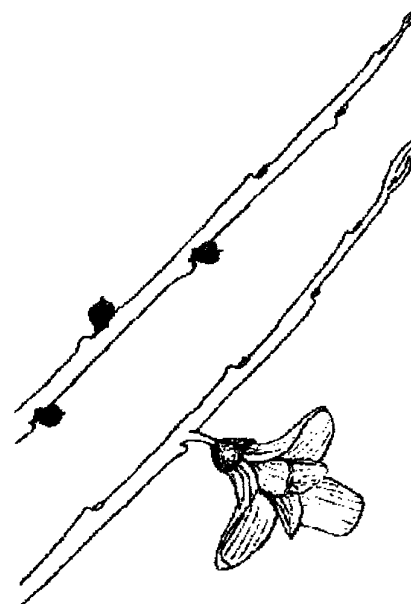
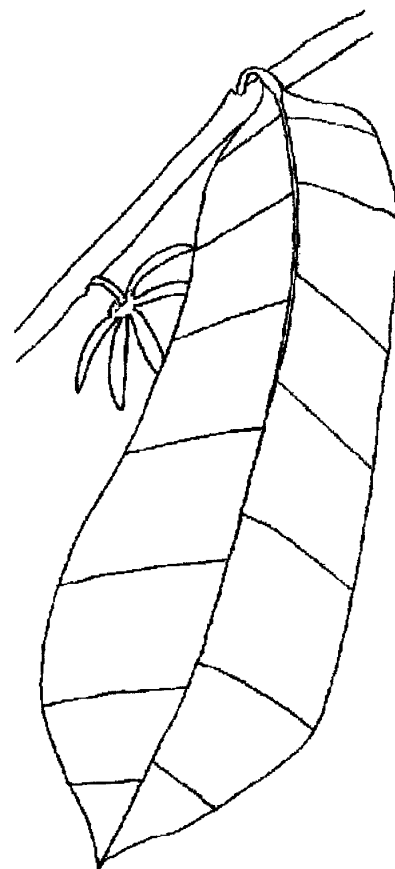
D. Pawpaws can bear in five years from transplants when 4 in./8 cm. diameter trees, and produce unblemished fruit without spraying.

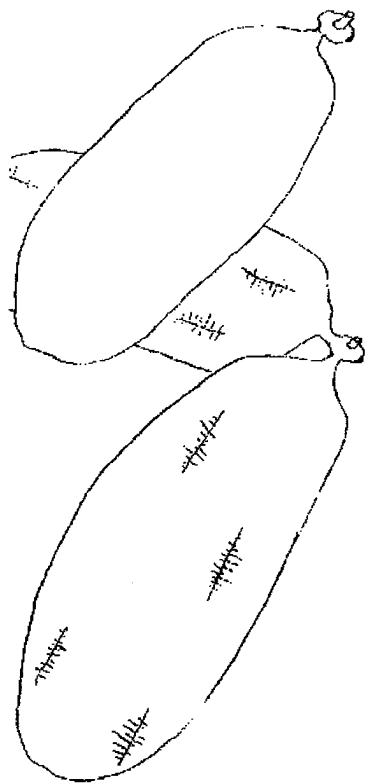
E. Pawpaws retain quality for weeks if stored in a very cool, humid environment, but ripen best off-the-tree beneath it in the grass. Brought into a warm, dry house, they usually degrade in a day.

II. Pawpaws need care: They need acid soil about pH 6.4, thus cannot be watered with well water unless some agricultural sulfuric acid is added. Planting a **bare root** tree is behind a wide board in partial sun because leafing is slowed by transplanting that leaves sunburn trying to emerge. **Potted** pawpaws grow fast enough to withstand full sun, and so do transplants the **next** growing season. Pawpaw fruit are hand harvested by tipping the fruit vertical to see it detach just within the ripe fruit. The fruit has to tree ripen, or ripen in the grass under the tree when wind blows down ripening fruit. The seeds are like dark nickels that are enjoyably sucked from the fruit, and taken to stratification **without** drying or freezing.

A. Pawpaws bloom in early May just before they leaf out. Blossoms are 1.5 in./4 cm. purple flowers bells at about 2 in./5 cm centers. Pawpaws set fruit on relatively few of their flowers, but the set flowers load the tree because each flower can make a cluster of about five pawpaws (though 2 or 3 fruit per cluster delivers the lager fruit of Overlease.) Clusters with 2 or 3 round fruit produce more flesh, less seed. The smallest number cluster can produce 16 oz/.5 kg fruit. Flower buds are a 3 mm. diameter velvety brown globe on scion wood. Leaf buds are 3 mm. by 1 mm. waxy-claw crescents. Pawpaws are about 6 in./15 cm. long. They resemble a greenish yellow frankfurter. Inside the flesh is at least one (usually 2) stacks of about 6, dark brown, boney hard, nickel size, glossy seeds. In a good pawpaw these seeds melt out smoothly into the mouth from the flesh.

B. In Ontario pawpaws are native on the north shore of Lake Erie, and along the Niagara Escarpment. Pawpaws have adapted as understory trees, especially in the open shade on the talus below the escarpment, with the best pawpaws on the edges of islands in streams where they irrigate themselves, dipping roots to the edge of water. They grow in cool, moist, leaf litter, and humus covered, soils. The soils themselves can be poor and shallow, the kind of soil along which running trees like pawpaw, beech, and persimmon spread. Pawpaws spread by sprouts off their surface roots, as well as seed. They spread easily along talus material at the base of cliffs to fill openings caused by cliff falls, felled trees, and mown rights-of-way. In the open they quickly become 10 in./25 cm. diameter, 35ft./10m. tall trees. Their smooth grey bark does not furrow. Small native magnolia trees (cucumber trees) are easily mistaken for pawpaw.



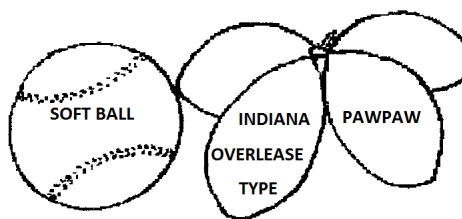


C. Pawpaws have very long, black, and wiry roots. One might expect this from an understory tree that forms groves by root extension. Lack of hair roots makes transplanting tricky. However, once pawpaw becomes established, their extensive root system makes the pawpaw very productive even when growing on a poor soil. The pawpaw seed carries endotheal root mycorrhiza within their seeds. Small trees, grown in the open, often yield baskets of fruit, but their fruit do better in soft shade with less sunburn, black patches and cracks. They are a big berry and need cool, moist culture as other big berries. Like other berries soaking rain near ripening can burst the fruit

D. A wild grove of pawpaw will often be barren of fruit, and speculation is that the grove is a single individual. Pawpaws have a complete flower. Flowers become receptive just before pollen is shed. These flowers bloom under moderated forest conditions just before they flush leaves. Both can be injured by a heavy freeze, but because the flowers bloom from the bottom of a stem to the top, some always escape the freeze. Insect pollination was suspected, but it took the recent observations of Corwin Davis to reveal the insect and how to attract it. Corwin identified carrion flies and beetles as the vector. The tedium of hand pollination (and this is the very light touch of a pencil eraser on pistil tip) is eliminated if a dead animal is introduced into the grove before bloom to get the territory well populated with carrion insects. Insects hide at night, and during poor weather in the tent-like pawpaw flowers.

III. Three classes of pawpaw can be described by their fruit ripening characteristics:

A. **Pennsylvania Golden pawpaw** ripens early September thru October. The smooth, thin, pear-like skin turns yellowish as the flesh softens on the tree in hot weather. The **flesh is yellow-orange**. The tree goes dormant in October, dropping pale yellow leaves with its fruit. These trees are found growing in talus formations in deep valleys, and on stream islands at the base of mountains throughout Pennsylvania. Pennsylvania golden pawpaws can have a chemical-coffee taste if ripened under hot dry conditions (This may be another case of ripening for the wrong reason, therefore aborting, not really ripening.) The selections Zimmerman and McKay have a mild flavor. Dr. L. H. MacDaniels named a seedling of Pennsylvania Golden the "Zimmerman" for this devoted breeder of pawpaw (MacDaniels' seed source). McKay's fruit is also traced back to Dr. Zimmerman. Several Pennsylvania nurserymen have distributed selections gathered clonally as root cuttings from Pennsylvania Golden groves near the Susquehanna River. These were mulched and pampered for a year before distribution. We are continuing this line as PA Golden because the typical fruit is pure confection with no hint of green pepper flavor (pawpaw scent), rubbery texture, or watery texture in its flesh.



B. **Cream fleshed pawpaw** ripen in Niagara in late September/October/November. Examples are **Overlease**, and **TayTwo** from the Michigan/Indiana boarder. The smooth, thin, pear like skin turns a transparent green with yellow underneath as the fruit ripens. Neal Peterson who headed the Pawpaw Foundation says you should test pawpaw for ripeness with only gentle finger pressure, or better, tip fruit upward to see if it breaks free of the stem. The pawpaws soften as they release from the tree. The ripe flesh is a **creamy yellow color**. Their flavor and texture is a fruity vanilla custard. Davis from West Virginia and Sunflower from Kansas are larger, later, and with a harsher

green-pepper-skin-taste after their at-first flavor, likely caused by ripening toward November. SAA Overlease is first of a series of Overlease seedlings, all twins of Overlease, ripening in early October. Campbell's NC-I is an Overlease/Davis cross, pound size, late October ripe in Niagara.

C. **White fleshed pawpaw** are from central Ohio, and last ripe/ November in Niagara. The skin is thick, lightly veined, and leathery. Their seeds seem early ripe. Usually, skin breaks down, turning from green to brownish, before the flesh softens. When soft ripe the skin is pared off before eating. If the season has been long, and the weather mild, the white fleshed pawpaw will have a sherbet/vanilla custard taste. Often the conditions are chancy, and the white fleshed pawpaw remains resinous and rubbery, turning grey and degrading before ripening. I only found one seedling that made a "white" selection in Niagara (probably Sauber seed). In warm 2010 it was perfect with a green skin. I kept looking at it, and wondering when I would get a repeat demonstration. Selections of white fleshed pawpaws are all but unknown, although Paul Sauber near Akron, Ohio selected hardy and productive "whites", which bear very large, very long fruit.

1. All pawpaw fruits degrade rapidly under hot and dry conditions. Unlike bananas they can endure freezing, and ripen with quality. Finger size fruit are almost all seed. Most fruit nurseries avoid pawpaw because of transplanting difficulty. Most people have not tasted a good pawpaw. However, if we could grow several baskets of well ripened fruit for our fall SONG/NYNGA meetings, there is little doubt that the meetings could be turned into pawpaw festivals.

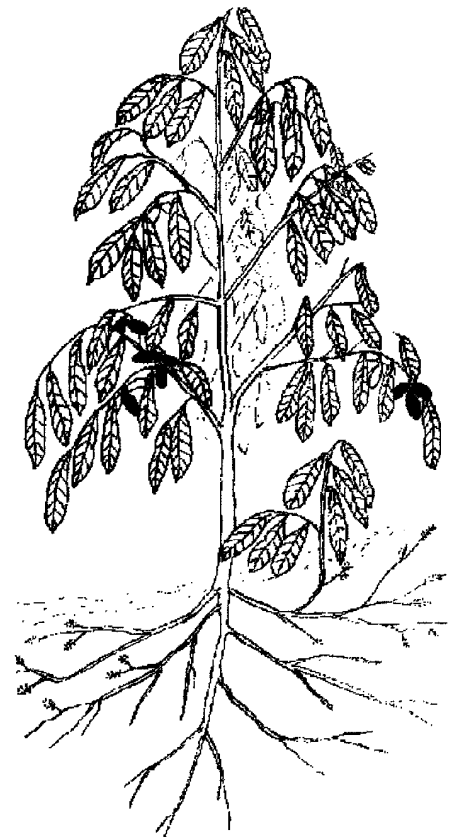
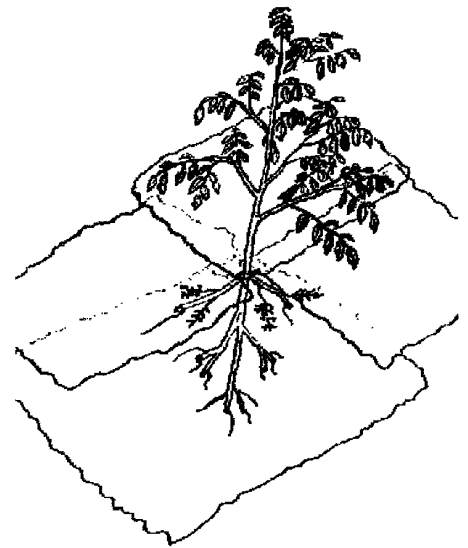
IV. Pawpaws germinate at a high rate if seed is not allowed to dry, or freeze below 25°F / -3°C. Pawpaw seedlings are slow to come up and are lost among the August weeds that crowd them. If you know pawpaw, you know pawpaw will lay on the ground all winter, and degrade to shed seed in a month, yet grow. What kills pawpaw seed is sitting in a pail in a detached garage at near air temperature, better to put that pail under a pile of sand on the concrete. Pawpaws germinate when soil temperature is 72°F to 85°F / 22°C, surfacing in Aug.

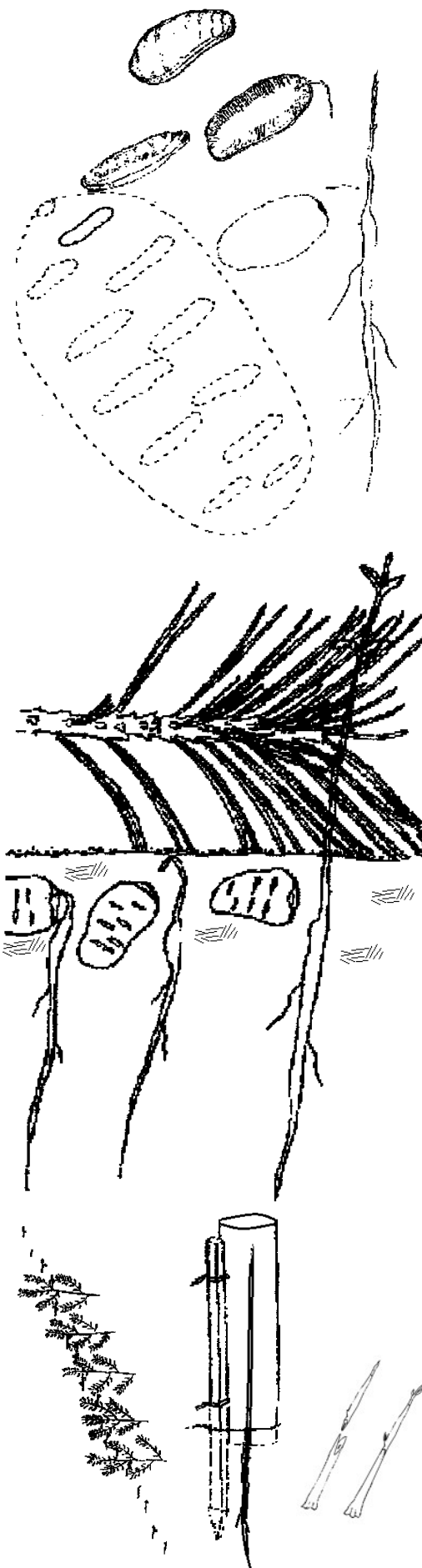
A. After the first mature pawpaw fruit falls to the ground, shake the tree a bit to remove ripening fruit. Some of the crop is usually unobserved among the large leaves. (These large leaves also make fruit thinning impossible.) Two weeks of intermittent harvesting during warm weather usually removes the crop.

B. Gather fruit into paper bags. Store them in a cool, moist, airy and shady location at 50°F / 10°C if possible. Pawpaws are best eaten just as they soften. Do not take un-ripe fruit into the warm, dry house, or it will stay resinous/become coffee tasting. Seed should be refrigerated in a crisper after being put into a plastic bag with damp peat moss. Do not allow the seed to dry. Unlike persimmon seed, pawpaw seed rarely molds, but if it does it can grow with a coat of white mold without injury.

C. If mold starts to appear on the fruit, transfer the fruit to a pail of cool water for further ripening, or cold water for delayed ripening. Maintain fresh water, if eating quality is needed.

D. Fall plant pawpaw seeds at 1 in./3 cm. centers in narrow beds. Pulp does not have to be completely removed from the seed. Cover with 1 in./3 cm. of dark earth, then 1 in./3 cm.





of chopped leaves and/or sawdust to prevent a tight, hot crust, and give some shade to emerging seedlings. In June/July add pine bows for more shade, or see paragraph G below.

E. To spring plant, pre-sprout seed in a 80°F /27°C wrapped in white plastic bags well mulched among strips of moist newspaper (until white roots can be seen emerging from scar ends of 1/3 of the seed). Sow the seed at 1 in./3 cm. centers in narrow beds. Seed without root will likely not germinate this first year.

F. Apply acid in June just as radar shows rain front, and you see it outside, spray to wet soil 1/2 cup Miracid + 1/2 cup/gal. agricultural sulfuric acid. Apply a herbicide spray of Roundup + simazine before August pawpaw emergence.

G. Shade screen pawpaws as they start to appear in July/August with pine bows. Pawpaws in a thick healthy stand can shade each other, but not in a drought or without acid soil. If leaves are yellow, add dilute acid just before rain shows up viewing radar. Pawpaws can be sown in rows, but shading them in narrow beds is better.

H. In their third growing season pawpaws should be spring dug and planted out. Pawpaw transplanting needs care and effort due to pawpaw root systems being sparse; only one wiry, spike root. Digging 0.5 meter long roots, planting in a tree growth tube shelter (sheltered only toward July when shelters become too hot for pawpaw.) Frequent watering is advised. Once established pawpaw can spread root and foliage, and bear on a shallow soil if near water. They are highly ornamental. Pawpaws prefer a cool moist soil. Heavy mulching with wood chips is advised. Pawpaw bark has a natural bad taste (similar to very strong green peppers) which discourages mouse, rabbit, even goat chewing. Be consistent with fertilizer. Broadcast 15-15-15 granular garden fertilizer each two months of growing season. Rate is 2 lb./1 kg. per 1 in./2.5 cm. stem diameter. Broadcast away from trees and past branch ends. Remove any pellets that touch young bark. Use Roundup + simazine as weeds and grass reach 6 in./15 cm. 2 m. spot around trees. Last spray should be simazine + Solicam at first fall frost. Soil is acid, moist, and cool.

I. Pawpaws which are heavy cropping will need feeding. 700 kg. of 15-15-15 fertilizer in yearly split additions per acre is necessary to maintain production.

J. Tree spacing is similar to filbert spacing. Mature trees will do well 25 ft./8 m. tall, or 25 ft./8 m. centers. They suffer the same lost production as filberts when planted in a wind swept location. At windy sites their leaves may be stunted, and the tree killed. They do best in a sheltered cover which gets lots of morning sun. Unlike filberts pawpaw prefer a moist location. They do better at the base of a hill, and filberts do better farther up hill, low on the brow.

V. Pawpaws graft easily at one foot/30 cm. level. Dormant tip scions are thin, but they retain life, and graft with 90% success, if all the energy of the stock is forced through the scion. Getting pawpaws established is a challenge due to their sparse root system. Transplants leaf out so weakly that their leaves need noon shade and fast growth in acid soil, or they sunburn off without coloring green. Tree shelters promote rapid growth, and greening of leaves, but heat in shelters is too high in July, so shelters must come off at 80°F /27°C . Selections generated from root cuttings are highest value. People should evaluate seedlings, then top-work deficient pawpaws. Mainly Overlease comes true from seed, likely due to its larger tree, size being more competitive, and an easy selection. The very early pawpaws that are most needed in Niagara are few, so usually need to be grafted, or started from root cuttings. Like persimmons, pawpaws easily sprout from shallow roots, so transplanting root cuttings from select seedlings is needed by fruit growers, but more needed by nature preserves.

VI. Pawpaws are health food. Eating the fruit, the semi-bitter skin can be chewed, letting the green pepper flavor sooth a sore throat, and fight a post nasal drip. Twigs have this flavor, high in anti-cancer benzene ring chemicals. During the off season I paste gummed Aldi's mango licorice to the roof of my mouth for a soothing, but a minor treatment. Google *Annona sericea*, pawpaw, cancer.

GRAFTING AND BUDDING

(BENCH GRAFTING, DORMANT CHIP BUDDING MAYDORMANT GRAFTING, MAY DORMANT ON GREENWOOD GRAFTING, JUNE GREENWOOD GRAFTING, AUGUST SLIP BUDDING)

I. Grafting is a loose term for making a mechanical union which grows selections and root stocks together.

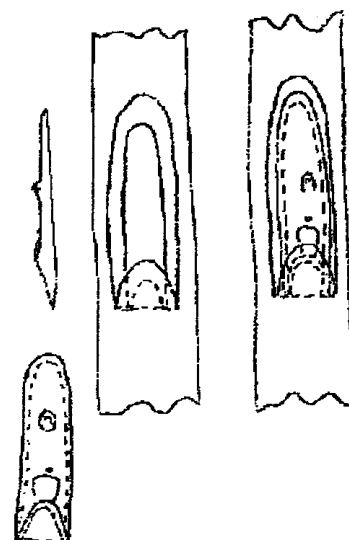
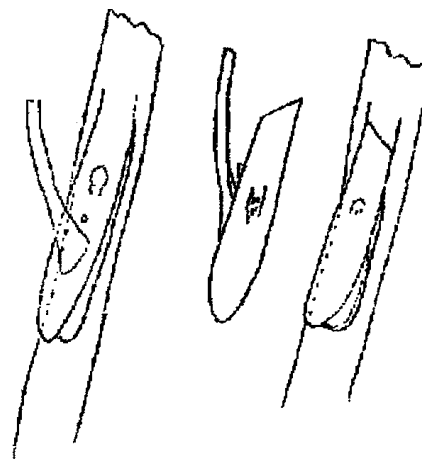
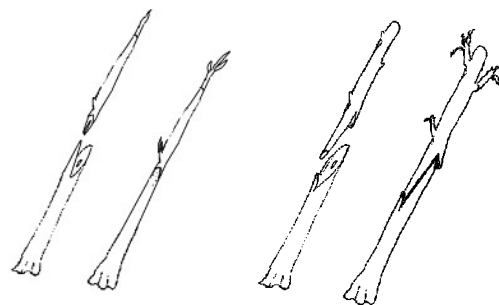
A. Grafting and growing go hand in hand. We plant a few trees, watch them grow, and wonder why we did not plant earlier, more, and better. So it is with grafting. We set a few grafts. They grow. The way is open to gathering, grafting, growing, and observing the more unusual selections.

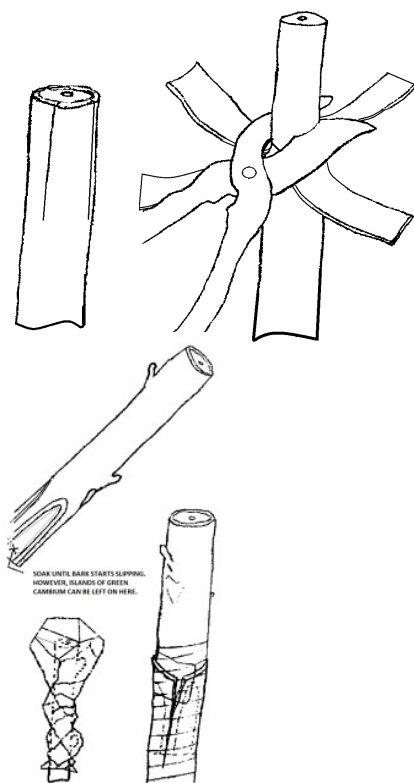
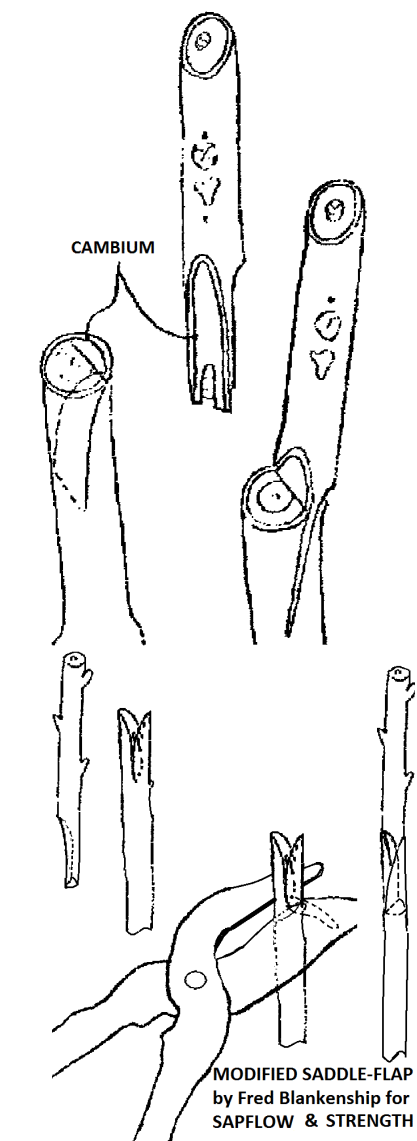
B. Grafting multiplies a selection, using its branchlets to replace the tops of seedlings. Budding can do the same, twisting off a flap of bark with a single bud that attaches the selection to the side of a seedling. Grafting cuts into the wood to butt the living tissue layers, cambium on each edge of the cut. Budding is better because it raises a flap of glistening/growing cambium to match, and mate with all the glistening cells growing beneath a flap of bark raised from the stock. The glistening patches can immediately unite to continue growth more consistently than matching edges of cambium. Pecan and hickory seem to bud easily; easily caught at the time of rapid cambium growth as noted by easy slipping of the bark, but chestnut and walnut also have this stage, though at a cooler, shorter (trickier) glistening period. That is why most pecan grafting is of a bark graft union combining grafting and budding. Chip budding is middle ground used to set a bud at time of frost; no bark patch/slipping. The three flap "graft" of pecan takes advantage of bark slipping to contact a massive area of cambium, and continue the strong growth of a scion with several large buds that are dormant.

C. Grafting and budding give us a tree with seedling roots and a "mature", selected top. A year after moving the seedling top of a budded tree, the budded tree should be identical to a grafted tree. We generally speak of a "grafted" tree, but what underlies the union is either a "grafted", or "budded" stock.

D. Grafted trees are much different from seedlings. The difference is that we set down low what used to be the top of a more mature tree. It was a super tree which had shorter, stockier terminals; darker green, glossier leaves; large, projected buds full of flowers; well socketed, drooping limbs; and delightful fruit. Choice graft wood is usually stout terminal wood from a fast growing young grafted tree. Our reward for grafting is another of these trees to better manage.

E. The bad news is that we really do have to manage a grafted tree. They are easily stressed. They grow slower, especially when allowed to carry full crops. Nuts can be small due to the likelihood of starved roots. The new bark injures easily from southwest sun, then freezing, because it is from higher up, and not prepared to be low to the ground. Deer, rabbits and mice eat the sweeter bark above a union. Low grafts are often banked with earth to moderate freeze-thaw until the second year after grafting.





F. Budding transfers the selection to the side of the seedling as a single bud. Always think **slip buds**. Slip buds slide into virgin cambium which never has been injured, and never will see direct sunlight. Slip buds (T, H, or any form of flap) lodge their own bark cambium at the point of deepest penetration into stock cambium. Resistance to penetration determines the greatest manageable depth of penetration. Any readjusting usually ruins this union. Grasp petiole, and a shield of bark, then, twist-wiped it from the bud stick so as to retain a plug of bud pith behind the bud. The pith plug must be surrounded by a glistening wet surface of cambium cells as found under water /heat activated bark, or the slip bud seldom works. This shield is worked into a slit in similarly slipping bark of the seedling stock to fit glistening cambiums together like a native bud. Even minimum air and light exposure injures the cells of cambium surfaces. The bud and leaf continue to function. Moisture and cambium cells flow through the cambium contact. Normal vegetative growth continues, and is completely redirected by breaking over the seedling top in three weeks. Later the seedling old top is completely removed.

G. Grafting transfers the selection to the seedling as a stem piece, scion, inserting it into the cut-back top of the seedling. The scion has several buds. The lower cut across the scion matches the cut across the seedling to get a continuous mechanical union. Cambium contact is along a line just under the bark. Moisture flow is broken. Moisture flow must re-establish in three, or less, weeks. Even in perfect grafts, callus cells pushing from the cambiums meet and unite to re-establish moisture flow. The scion must lose little water for three weeks, or percent survival will be poor.

H. Side-bark grafting allows semi-slipping cambiums to continue cell and moisture travel, thus allows moisture loss from scions which are swelling buds. It approximates slip budding in a small area. Side-bark grafts have the bark at scion points shaved to the cambium to instantly unite with the stock cambium when they are driven together as uninjured cambiums, for instant cambium circulation, lapping small glistening areas of cambium.

I. Chip budding also extends to this middle ground between budding and grafting. It is grafting. There is no bark slipping. So why do it? Early-to-leaf (heartnut) species are chip budded because they will callus under sun warmed bark before slipping/bleeding occurs in early leafing heartnuts which are built to start leafing and draining moisture in the first hot spell before any callus union. Heartnuts have no bud scales or socks, and sticky wax is little help in a hot spell. High sap sugar is the anti-freeze that keeps them going, and "boiling-off" moisture as a frost protection. (The variety Canoka has the highest sugar sap and comes through frost/freeze best.) Use a chip of wood, non-slipping bark, and a tiny bud, all are cut from a bud stick. A seat is cut in the side of the seedling to fit the chip bud. Cambiums are active but not slipping. Bleeding is being overcome, by cool nights, not cutting deep into the stock, accurate fitting of the chip with no gaps, and snug binding. The chip has to be faced to warm sun for callusing. The small bud in the chip will start to expand when the seedling top is bent over, so it must be allowed through the binding by weakening the binding with a Teflon window or pulling the plastic binding with an o-ring pick.

J. Flap grafting unites large diameter stocks and scions with slipping bark. Where wood butts it is sheared across horizontally, and scion revolved into best fit. For this the wood plug from the stock is immediately replaced to seal the flaps from air and sun until a matching scion is shaved. Of course you noticed how poor your horizontal cut on the plug was so you can match it on the scion.

II. Usually, dormant scion wood is cut in late February and early March. Persian walnut and other tender species are gathered before deep cold; gathered before arctic weather is forecast to arrive. Filbert and heartnut (also most walnut and *C. mas*) move early so they are gathered first. Pecan, hickory, and fruit (if they stay dormant like persimmon/pawpaw) are gathered late, when they are full of moisture. We usually want scion wood full of moisture as a preservative of life, starter of callusing, therefore we wait for a few mild days in spring to bump up moisture, then cut. However, walnut should be devoid of moisture, and have small buds, or leaves flush quickly, which dry out scions before any callusing.

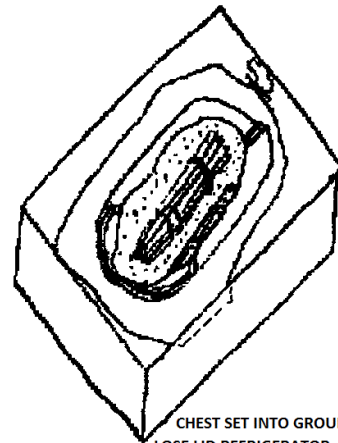
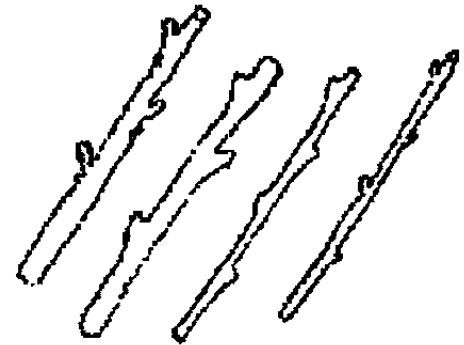
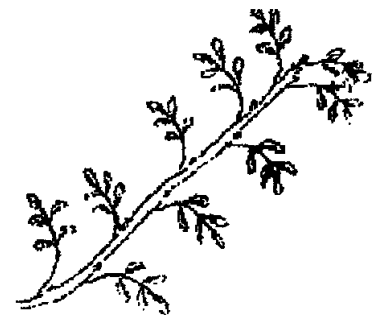
A. Greenwood scions and stocks are ready in early June, when wood is forming/tissue is stiff against cutting, is not celery/non-shriveling-when-drying, but pitch is gelatinous/not separated.

B. July-August slip budding sticks and stocks are ready when watering forces bark to slip. Both stocks and scions are soaked to start bark slipping.

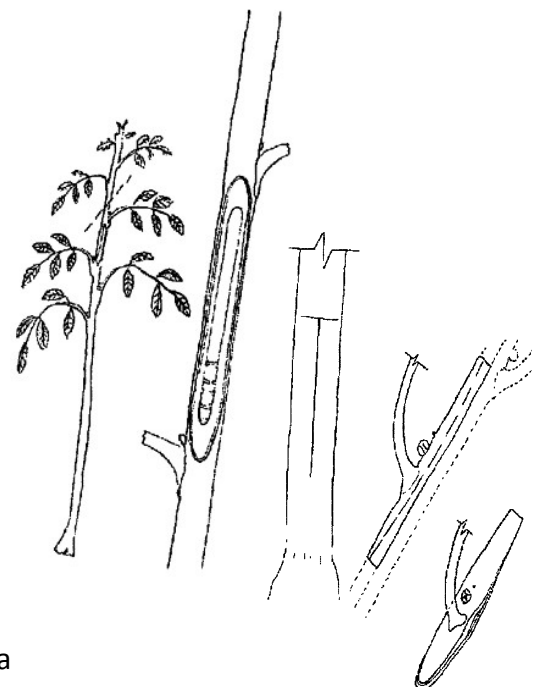
C. Dormant scions need preparation for storage. September/October gathering is not successful except the gathering of large diameter two and tree year wood far from home during pecan nut evaluation. New pecan wood and buds will not store from nut gathering time, but old pecan wood with many blind buds will force. Hold it cool with moist newspaper to hold leaves moist in the shade, in white plastic bags until their leaves slough. Then a short refrigeration in plastic, followed by a day out in the fall rain to refresh their moisture and helped destroy mold. Temporary storage is a quick brushing on of paraffin to seal buds, and cuts, sealing cut ends for a few weeks of cold storage. Then precut scions, dip in grafting wax, and hold in cold storage until spring. These are double bagged in bread wrapper plastic bags, sealed to hold in moisture with moist paper strips. A third paper bag is to moderate the rapid freezing /thawing in the refrigerator. This is not your wife's refrigerator, but the extra one set just below freezing in the basement.

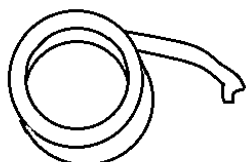
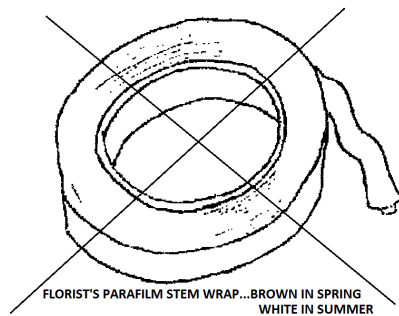
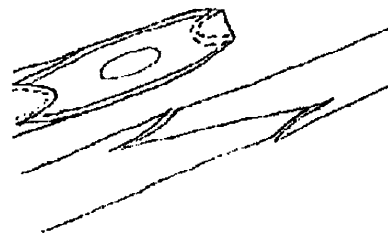
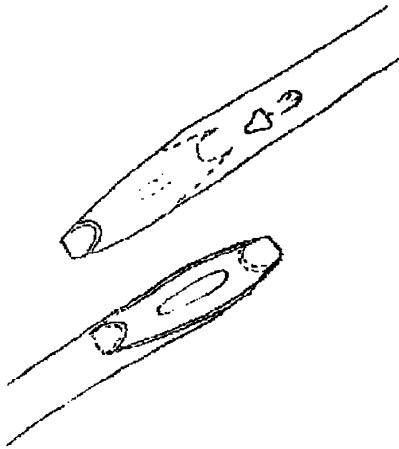
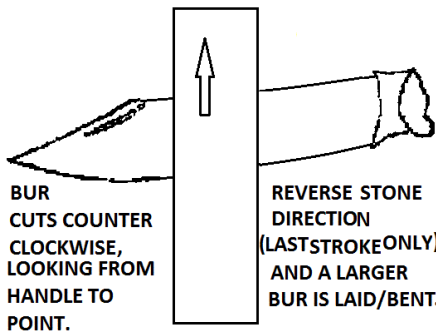
D. Gather dormant spring scion wood before long thawing is expected. Persian walnut scions need cutting before any a of 0°F/-18°C. All the male catkin buds are rubbed off (these look like tiny pine cones.) Dry the scions off for a day or two in an unheated room. Precut square end scions (low end will be wedge cut at grafting) 4 in. to 6in./10 cm. to 15 cm. long, two or three buds. Wax by dipping in grafting wax, or your own mix of paraffin, bee's wax, resin, tallow, IBA. Use a clay pot slow cooker so you can set a low temperature, and wax is not smoking. You can dip a finger tip to seal any bubbles coming from the cut ends. Scions should be held in an unheated room for a day. This seems to allow some scion shrinkage and wax flow. The wax sometimes cracks if immediately refrigerated. There was a slave who propagated Stuart pecan, and his graft sealer was a press coat of Mississippi gumbo clay/tallow mix. This must have been a deep stuck bark graft, bound with rag strips.

E. Scions for dormant grafting are waxed and stored for months. A special refrigerator set at freezing, 28°F/-2°C, is needed to store dormant scions the several months until spring grafting. Even at freezing temperatures moisture is drawn to the walls of the scion package. We should insulate the package and double wrap the scions in two plastic bags/ one paper bag. The inner bag contains the scions and only damp paper strips. The outer bag contains the inner bag wrapped in wet newspaper. The outer layer is a



CHEST SET INTO GROUND -
LOSE LID REFRIGERATOR
DRILLED WITH BOTTOM DRAIN HOLES





F Bud sticks in leaf are often held with ice for short periods. Waxing would encumber bud selection, and removal. Chip bud sticks are dormant, waxed, double plastic bagged, with strips of moist newspaper/wet newspaper added to the outer side. Slip bud sticks in leaf are usually used just after gathering, but can go wrapped in moist paper toweling in a plastic bag into the vegetable crisper, and be soaked in fresh water until bark is slipping.

G. Windows of opportunity open and close throughout the year. Some of the critical times and activities are: as fall sets in, nuts and trees are evaluated, and dormant scion collected while handy. Persian walnut wood is cold-tender so has to be collected at least the day before first arctic cold is forecast. Avoid Persian wood with brown bark spots/blight. Some years 0°F/-18°C temperatures are not reached, and Persian wood can be collected with other wood Feb./March. Dormant scions of heartnut should be taken at their highest rest/dormancy in late February, definitely before sap is up in March thaws when most wood is gathered.

H. Greenwood is gathered when wood is forming, but pith is stiff, between jelly and bead-separating where you want the union.

I. Grafting material is gathered late because, the later gathered, the less chance of storage failure. Grafting is held off to avoid frost, cool weather and heavy rains at grafting. However, grafting *C. mas*, chestnut, heartnut, and filbert, and chip budding has to risk some frost, or grafting is too late and grafts fail soon after growing a few leaves due to hot weather and the need for early-spring-growth stimulation. Late chip budding fails by running into the bleeding season. May is your month to graft pine, walnut, pawpaw, persimmon, hickory, and pecan in the field. It is possible to dormant graft hickory on greenwood to end the spring grafting season, if insects have not arrived.

J. In late May hickory puts on its spurt of growth and sets its terminal bud. We have to catch it with wood stiffening near its fourth node, above three well sized leaves, with pith gelatinous, not separated. A few days too early and the stock shrinks from the union. Days late and growth pushed from the scion is so weak that it hardly extends. Such weak growth rarely survives the summer.

K. Knife size, shape, and sharpening is important. Wielding knives safely comes from locking hands/palms/fingers to limit knife travel. A long stroke eases the force needed to penetrate wood. Build a sharp edge which slits paper into strips when drawn across. Stroke sharpening toward the blade's sharpness. The last strokes leave the bur on the side of the blade opposite the stone's attack. This bur is pointing the way the knife turns/curves into the wood. Clean the blade of hand oil, etc. with cuts into scrap stock wood.

III. Graft union shape varies with knife skill, strength needed against wind, speed desired in grafting, versus quick callusing. Grafting machines rapidly turn out unions by striking a notch in the stock, and a point on the scion. A sharp, long, pointed knife easily carves this notch in the greenwood stocks, but grafting machines notch hardwood more easily. Two wing shaped knives are held together to form a point, and are levered through the wood in the original French grafting machines. Continue wielding a knife, and you can gain adequate speed in outdoor grafting.

A **The English graft** (also called the heal and toe graft due to the location of notches where callusing first forms) slices easily because the notches are small, and close to the ends of a splice graft. The thin side of the notch flexes to free the knife without wood splitting, and bends to the shape of the scion. The slant cut across the scion is as the only cut in a simple splice graft. The point is the toe. The end notch opposite the toe is the heel. The fit should be tight to let it stand free for inspection for cambium match-up, and absence of gaps. The notches increase in gripping power with callusing. Toes are buried so they won't dry and die as in splice grafts. Shaving the bark side of the toe to expose cambium improves its healing-in.

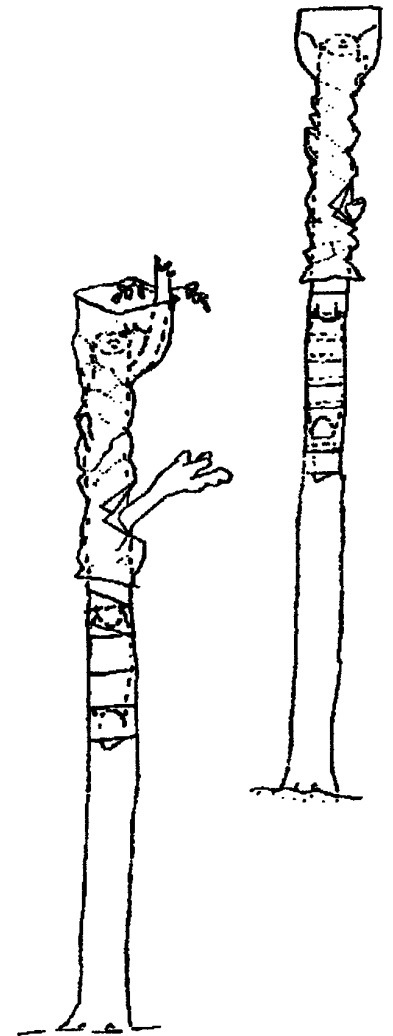
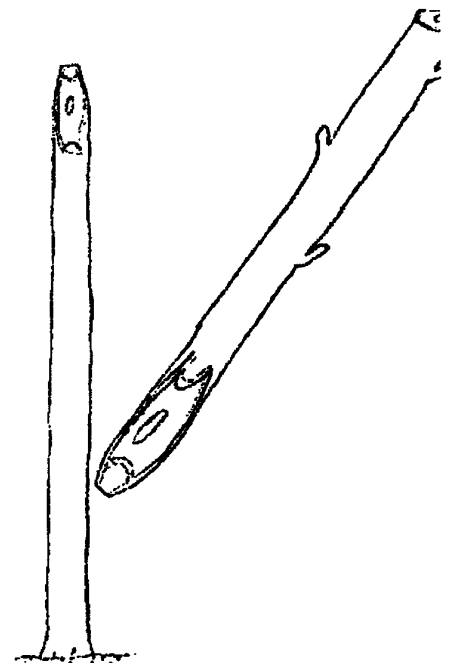
B. **Bind the graft union:** to seal against moisture loss, close openings in the union, convert sunlight to heat (ultraviolet light kills callus tissue),

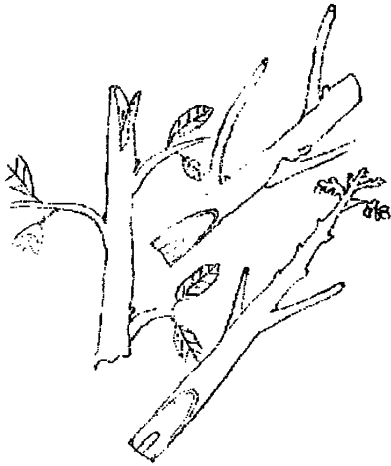
and add strength to the union. Plumber's Teflon thread sealing tape is in hardware stores, and is great to use. Teflon is inert, seals moisture, and never girdles, so is left on for years to identify unions and grafts. Tension used in wrapping takes a bit of getting used to because too much tension and the Teflon becomes a string, so re-widen the Teflon with a finger tip during wrapping it upward, pulling it to seal the union, and semi-weld to itself with pressure. For a short time Teflon does not stick to itself, but will in a week or two. Inverted saddle walnut and hickory grafts can unwind Teflon so a temporary loop of electrical tape is needed at nibs (3M Blended hospital tape is more weatherproof), or masking tape, sticky to sticky, is good for pawpaw. Because callusing bulges inside the V, saddle grafts are forced open by callusing, ejecting the scions if binding is impermanent.

C. Aluminum foil, extra heavy foil wrap, limits the number of buds which can flush, or be dried by the wind, until the union is fully mended. The ideal jacket would: allow unions to warm in the sun, reflect sun to keep the buds cool, and in stasis, allow fresh rain to wet the scion, cycle between condensation, and high humidity daily, and unfold like a deep bud coat as the bottom, and top buds move. If there are only one or two buds on a scion, there is less need for aluminum foil because the sealed union should transmit enough water to sustain two-bud flushing. Aluminum foil can be wrapped and crimped to meet these needs. A crimped cylinder of foil sleeves the scion from the lowest bud, to 1 cm. above the top bud. Before crimping the sleeve is loose, touching the scion on several sides, but fits snugly after crimping. If a crow comes to investigate, the scion has to be waxed, and foil lose, or the graft gets pecked apart. The top of the sleeve is flattened for easy opening, not crimped from all sides. Until bud extension opens the top, rain entry will be slight and drawn between plies. As the buds swell on their own reserves, the foil should remain as a cover. As the bud growth extends, the foil should unfold slowly to block direct wind and sun. In the fourth week shoot growth should be centimeters long indicating a successful union. Remove the foil, and avoid crows.

D. Plastic bags are the necessary vapor barrier when grafting very early to tarp some heat for callusing, and ward off some frost; also needed at greenwood, or bud swelled scions. These bags are sealed against the stock below the union (masking taped). White spray paint is applied to the top, and south of the bag's sides to moderate the heating of direct sun. Growth in the bag will often be vigorous due to warm humid conditions, and seldom due to union re-build, but judge by the 2 in./ 5 cm. flushing about the fourth week. The bag will have to be removed, maybe in the third week due to mold problems. Bags need to be checked regularly for wind damage, especially if a weed stalk bag spreader is used, and collected rain water enters, and must be dumped.

E. The bark of a slip bud should be sealed by tight binding, avoiding the complete cover of the bud. If the petiole does not slough it should project and continue to function as a tiny leaf with moisture flowing through the cambium. The film directly pressing on the bud should be thin plastic, like a loop of Teflon, to allow the bud to break into the air.





F. Renewal of growth from the stock should accompany the scion growth. If it is not so, you should suspect stock failure as a probable cause of graft failure. Upon graft growth, pinch off stock re-growth. Direct all the stock's growth through the scion by removing any stock sprouting that is within 2 ft./60 cm. of the graft union. Budding, and side grafting, page NUT PINE 105, are exceptions where healing-in is promoted by the stock continuing its normal circulation above the union for two to three weeks .

G. Hot pipe callusing is used during late fall and winter. It is an indoor operation much like bench grafting. It is possible because cambium is active unless refrigerated. Seedlings and scions should remain dormant; this is the theory, anyway, if they do not, keep them from freezing. Hot pipe callusing goes with cold storage, or green housing after callusing. A 4 in./10 cm. plastic pipe sleeves a much smaller pipe holding warm water from a heat tape. The heat tape is adjusted to maintain callusing temperature usually only 70°F/20°C in the pipes. The plastic pipe is saw cut to cradle tree stems (graft unions mainly). The slotted plastic pipe is covered with foam rubber which is slit at each cradle to seal heat over unions after they enter the slot. To be sure of insulation, lay another run of shag carpet above the foam rubber. Scions are about 8 in./20 cm. long to allow for some injury to buds near the union due to flushing/drying. Away from the heat pipe the air is below 50°F/10°C, and still. The unions are press fit into the pipe through the slits in the foam rubber. Thus, the unions have to be strong, and well bound with Teflon and Blendederm which will remove itself as the trees grow. The scions and especially the cut upper ends of scions are pre-waxed, and damp cloth covered. Moist sawdust, or potting soil over the roots keeps roots functioning.



H. Plastic tags, or tags made from pool liner, can be written on with graphite pencil. They last many years, if doubled, looped and hung so they slowly extend (friction slit in loop) on a growing branch.

1. Indoor Bench Grafting Advantages:

- a. Callusing is maximized due to control of heat and water (humidity.)
- b. Initial success rate is high, conserving rare graft wood.
- c. Root injury is healed by the conditions that promote callusing.
- d. A short period of container growing which accompanies bench grafting increases rooting, and aids transplanting.
- e. Indoor bench grafting in early spring is relatively convenient and comfortable.
- f. Planting out can be in close packed rows.

2. Indoor Bench Grafting disadvantages:

- a. Setup for bench grafting is time consuming, requiring extra steps in digging, storage, incubating, potting, lath housing, replanting small trees, and staking tree shelters that direct graft growth vertical.
- b. Growth stalls after grafting unless the trees are potted, and moved to a lath house, or greenhouse.
- c. Container growing requires daily attention
- d. Small grafted trees need attention, protection, and no torquing.

3. Indoor Bench Grafting materials:

- a. Large tub of inert damp sawdust, or potting soil, and a plastic canopy or cover.
- b. A small room which can be kept at callusing temperature, usually by the added heat of a space heater in a corner.

c. Small, flushing root stocks, and matching dormant scions, usually 5/8 in. to 3/8 in./1.5 cm. to 1 cm. in diameter. Scions are lightly waxed with paraffin.

d. Kit: grafting machine, pointed knife, pruning shears, Teflon, masking tape, slow cooker with melted grafting wax, brush, pencil, labels.

4. Indoor Bench Grafting method:

a. Match scion to stock. Scions may be slightly larger because callus blooms outward from the stock. Smaller scions will work if one side matches, and the other side is beveled to flow callus together.

b. Cut the scion and stock to a flat 1.5 in./4 cm. wedge and cusp. Cut across the stock 2/3 to produce a narrow base nib which is weak and bends on insertion of the scion without splitting the stock.

c. Push the stock and scion together until they best match, and almost lock cambiums all around. Ideally, no clearance can be seen between scion and stock except at the shoulders of the union.

d. Tape the union with Teflon from bottom up, and bind the nibs of the stock with a turn of masking tape. The Teflon can be eliminated by a good union, painting the union with wax, and potting so movement of grafts does not accidentally put any torque on the scions.

e. With grafting wax seal over the union, and all wounds on scion, especially top and bottom of the masking tape, and a bit under it where no Teflon was used. A good seal with masking tape is quicker than waxing.

f. Label and incubate the grafts. The roots go beneath the damp sawdust. Some people have antiseptic sawdust and bury scions. Some people have greenhouse conditions and pure water for misting grafts. They use high humidity and indirect light to grow leaves during callusing. Heating in the tub should be uniform, or warm areas will dry out, and cool areas will moisten with condensation. Approximate callusing temperatures are: *Prunus*, apple, pear 74°F/24°C; pawpaw, chestnut, filbert 78°F/26°C; persimmon, walnut, heartnut, butternut, hickory, hican, pecan 82°F/28°C. By the third week of callusing you should see callus tissue ballooning from waxed cambium.

g. Incubate for 4 weeks at 100% humidity, or high humidity and mist. Bud break will not dry out scions, but misting should avoid hitting leaves so pieces of linen sheet moistened intermittently with hypochlorite (avoid the new type Chlorox) solution two tablespoon/gal. should be draped over walnuts scions so the misting is screened by the linen. The bad news is that these conditions will maintain scion growth although the unions have not knit. The humidity must lower at night to surface dry the plants, or blight diseases will take a toll on Persians and heartnut. Some nut growers move the whole bench graft tub to the lath house to not disturb the bench grafts. Wait for 3 in./7.5 cm. of scion growth before moving grafts to potting. Carefully rub buds and sprouts from the stocks which you can reach, and probe them off as you see their growth.

h. Move containered trees to a lath house. Freezing will kill them. Wind shake will slow them, but strengthen growth. Some humid location, where light, heat, and cold are moderated, is necessary to promote some healing while hardening. Potted trees continue to need attention, but less misting/watering, maybe.

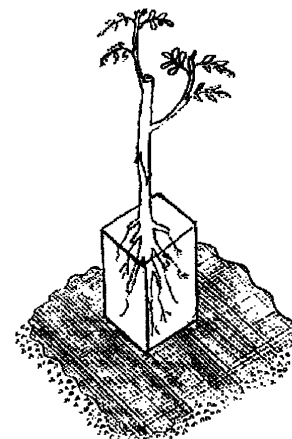
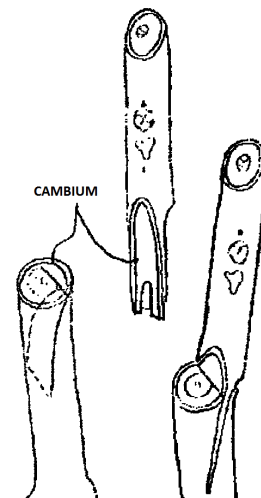
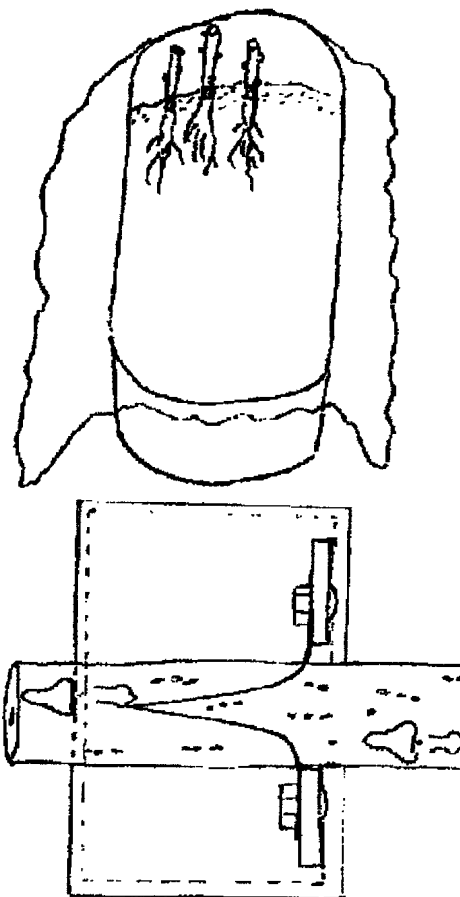
j. Plant bench grafted/hardened trees outside into tree shelters when terminals are out 4 in./10 cm. to get these terminals growing straight up.

5 Chip Budding advantages:

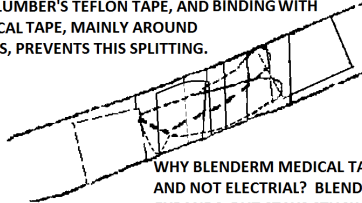
a. Chip buds callus-in due to sun warmed bark in April/May.

b. The small bud and chip lack the reserves to flush on their own, and are regulated by terminal growth to initially callus-in.

c. Early budding, cool nights, small wounds, and snug binding prevent bleeding.

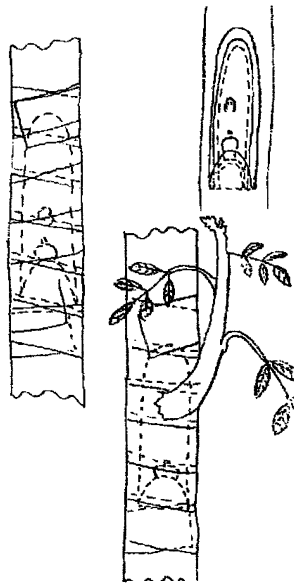
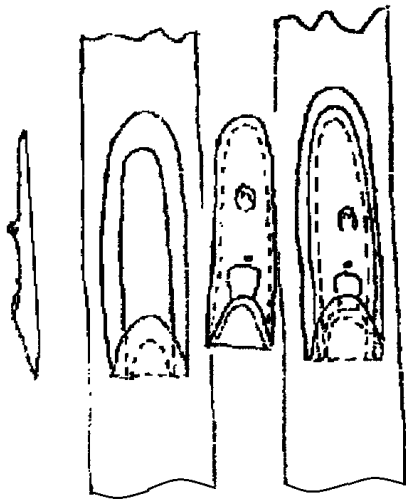


SADDLE GRAFTS PUSH APART DUE TO CALLUS TISSUE STRONGLY EXPANDING UP THE NIBS OF THE SADDLE. SEALING THE UNION WITH PLUMBER'S TEFLON TAPE, AND BINDING WITH A MEDICAL TAPE, MAINLY AROUND THE NIBS, PREVENTS THIS SPLITTING.



SO TRY BLANKENSHIP'S MODIFIED FLAP.

WHY BLENDERM MEDICAL TAPE AND NOT ELECTRICAL? BLENDERM EXPANDS, BUT STAYS STUCK.



- d. Flat chips make chip budding quick, and simple.
6. Chip Budding disadvantages:
 - a. The tiniest buds on a bud stock work best.
 - b. Warm rains cause bleeding, ending the chip bud season, usually with the first mosquito.
 - c. Frost can kill sprouted buds.
 - d. Partially sever, bend/break the stocks top to get the bud to move. Rapidly growing buds must be tied, then staked, to avoid blow-outs.
7. Chip Budding materials:
 - a. Gather dormant bud sticks in February/March before bud swell, and lightly brushed with paraffin, cut ends sealed, and double bagged with moist paper strips for storage at freezing, 28°F/-2°C. You could chip bud without storage if the earliest shrubs are leafing.
 - b. 1.5 in./4 cm. diameter root stocks in full sun with smooth bark. Bud activity is just starting with bright days and cold nights.
 - c. Budding kit: knife, plastic strips (1 in./2.5 cm. wide strips cut from plastic bags, Teflon tape is too weak), electrical tape, or clear first aid film if you have it, pencil, labels.
8. **Chip Budding** method:
 - a. Begin chip budding before buds on the stock begin their swell...frosty nights before hot weather produces mosquitos, and the full rush to spring.
 - b. Cut a 1 in./2 cm. bud chip by slicing downward and .5 cm. into the wood for a seat. Sever the chip by slicing diagonally downward 1 cm. to the base (completing the seat) of the first cut. The bud is in full sun on the south side of the stock. This bud shield looks similar to a slip bud shield except a veneer of wood remains behind this non-slipping bud instead of a plug of callus.
 - c. Select a small leaf bud from the bud stick and cut a larger than matching chip bud. Shave wood from behind the bud until the width between the cambial lines match.
 - d. Insert the chip bud in the seat on the stock. Inspect for gaps which must be shaved away to allow binding without air space which might fill with sap.
 - e. Wrap the entire union with vapor tight seal of plastic film strip. Wrap upward stretching the plastic film tight. Tie a friction tie above the chip, and end with a loop of sticky tape on the friction tie.
 - f. Do not lose track of the small bud because you should hook the plastic and pull a break into the plastic at the bud, using an o-ring pick, or similar.
 - g. After leaves start, break over the top of the stock, or cut it way back to force the chip bud into growth. The bud will pierce outward the plastic film. Buds which have not moved in five weeks should be unbound (slit plastic), and inspected.
 - h. At the end of five weeks cut off stocks 20 cm. above live buds. Wipe away buds from the stock.

i. As the bud extends 8 in./20 cm., drive a stake by it and tie the stock and shoot to the stake. If chip buds are not healing-in on all sides, tie it to the 20 cm. stub of the stock above the union when the bud extension is 15 cm.

j. In mid September cut the stub from the stock on an upward slant toward the bud from behind, ending just above the bud. Cover the wound with Elmer's glue.

9. **Dormant on Dormant Grafting** advantages:

a. Dormant scions have half the blight (if blight resisting and kept sprayed with copper sprays), and blowing loose problems of greenwood scions.

b. Dormant stocks are ready as soon as the weather warms.

c. After care is minimal.

d. Grafts grow most of the growing season, giving tender species like Persian walnut time to harden for winter.

e. Pines are usually dormant on dormant side grafts.

f. Dormant scions are easiest to buy, and get mailed.

10. **Dormant on Dormant Grafting** disadvantages:

a. Done early, dormant grafts of walnut and hickory species bleed with wet weather, and trapped sap ferments the union. Done late, the energy of the stock is wasted, and the new growth cannot flush without watering, or compete with the hoard of insects.

b. Scion wood has to be taken during full dormancy, and stored to retain full dormancy for months. Persian walnut scion wood is usually collected in fall before winter injury, so needs good cold storage.

11. **Dormant on Dormant Grafting** materials:

a. Root stocks with healthy terminals, 3/8 in./1 cm. diameter for chestnut.

b. Pre-waxed scions (chestnut, *C. mas*, filbert done at same frosty time, usually by saddle graft) cut to length, 5 in./12 cm. typically, with two or three fully dormant buds, one bud near the top.

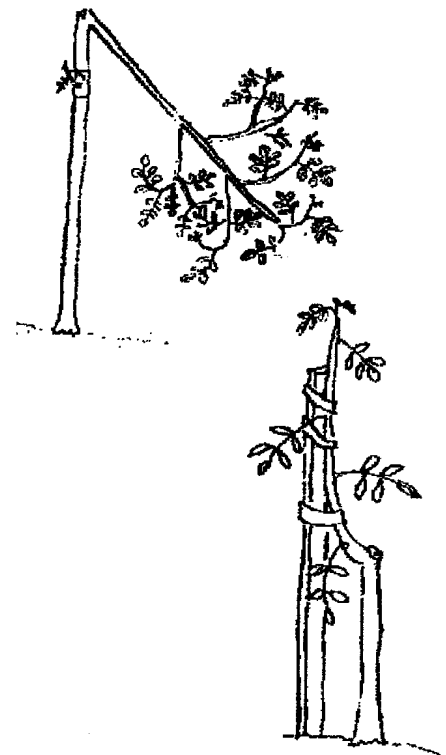
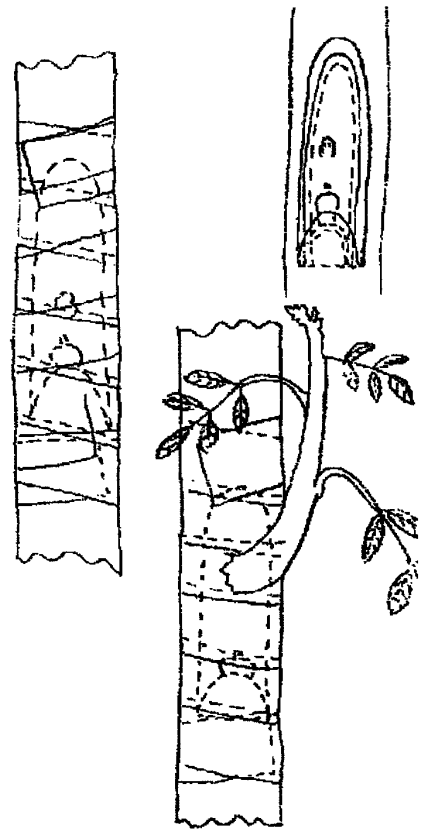
c. Grafting kit: sharp pointed knife, Teflon plumber's thread tape, masking tape, electrical tape...Blenderm hospital tape if you have it, small plastic food storage bags, weed flower stalks/ golden-rod, white spray paint, pencil, labels.

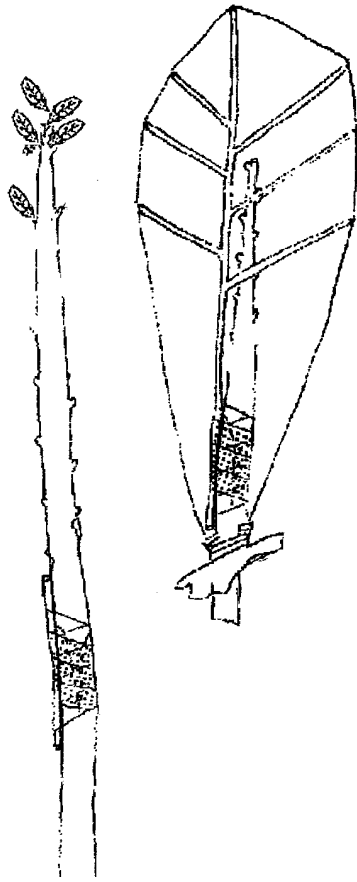
12. **Dormant on Dormant Grafting** : English graft method of chestnut.

a. Grafting is in late April/early May, which is time efficient, but mainly works with stocks that do not bleed like chestnut or filbert. Stocks that bleed, walnut, hickory, pecan, are often prepped in April by drilling a 1/8 in./3 mm. bit 8 in./20 cm. below the union, and left a week until their grafting. Top working a bleeding tree is helped by branch thinning below.

b. In early May match scion to stock, removing all leafing buds and competing growth below the union.

c. Cut the stock and the scion on a flat 3 cm. slant.





b. **The English graft** (also called the heel and toe graft due to the location of notches where callusing first forms) slices easily because scions and notches are small, and close the ends of a splice graft. The thin side of the notch flexes to free the knife without wood splitting, and bends to the shape of the scion. The slant cut across the scion is as the first cut in a simple splice 2 in./5 cm. long splice plane. The point is the toe. The end notch opposite the toe is in the heel. The fit should be tight to let it stand free for inspection of the cambium match-up, and avoid gaps. The notches increase in gripping power with callusing, thus use with chestnut. Toes are buried so they won't dry and die as is the problem in splice and modified splice grafts. Shaving the bark side of the toe to expose cambium improves its healing-in.

c. Tape the union with a vapor tight seal of Teflon. Draw the Teflon tight, but as it becomes a string, form it outward into a tape again with a finger tip, and continue to wrap. Teflon will weld to itself, but slips apart when freshly wrapped. Teflon must be friction tied at the first turn, and sticky taped at the last turn.

d. House the scion and union in a plastic bag spread by a dry golden rod flower cluster. Masking tape the goldenrod to stock so it spreads the bag around the scion. Masking tape the bag in a tight seal to the stock completely enclosing the goldenrod. Do not poke any holes into the bag with the pruned golden rod stems.

e. White spray paint top and south sides of the bag to reflect harsh sun.

f. Check the bag after wind and rain storms to dump water and patch any holes with tape/Elmer's glue. Remove stock generated buds by rubbing before their sprouts get large, or woody.

g. Watch the chestnut scion extend sprouts because the callus has not knit until extension is 2 in./5 cm., and small leaves are turning green.

h. Cut open any bag with healthy green extension to let it out. At the end of the fourth week remove all bagging (assuming growing weather is moderate).

13. **Dormant on dormant:** in early to late May; (first) heartnut, black walnut, shagbark hickory, shellbark hickory, hican, and pecan (last). Use pre-waxed scions. Wrap with extra heavy aluminum foil instead of plastic bagging.

a. Match stock to scion, usually in the 5/8 in. to 3/8 in./1.5 cm. to 1 cm. range. Shear off top of stock.

b. Locking hands, cut a cusp into the top of the stock by cutting one forward saw stroke into the stock just inside the cambium, curving downward to end 1.5 in./4 cm. down and 2/3 the way across the stock. The next forward saw stroke pierces in at the base of the first cut, and curves upward and out just inside the cambium on the opposite side to remove a cusp of wood.

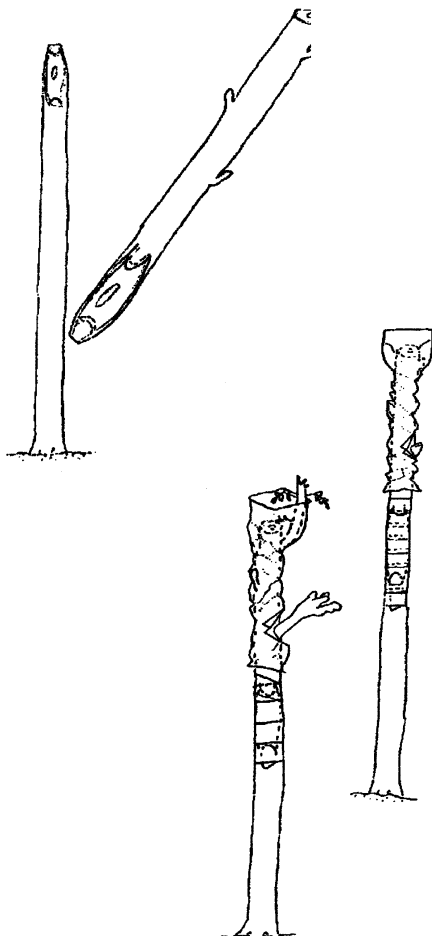
c. Draw cut chips from the pre-waxed scion chosen to match the cusp in the stock.

d. Press the scion and stock together to almost lock in the scion, but be satisfied with the best match of cambium opposite cambium with no gaps except at the top of the stock where shoulders likely meet part way.

e. Wrap the entire union with a vapor tight seal of Teflon. Draw tight, to pull Teflon toward being a string, but stretch the Teflon wide again with a finger tip. In this fashion spiral the Teflon up the stock in an air tight seal to above the nibs. Callusing will stretch the Teflon to try to unwind it, so bind the nibs with a clamp of masking tape. The Teflon will weld, and be a unit, stretching out for years.

f. Wrap the scion with aluminum foil, crimping it on, but only flattening the top so the extending scion can unfold it. When checking back in coming weeks, rub out growth from the stock.

g. Hope for no rain that could cause bleeding in the next three weeks, and a heavy enough rain in the fourth week to send the scion into full growth, or irrigate.



14. **Dormant on Greenwood Grafting** advantages:

- a. Carbohydrate manufacturing leaves are retained on the stock to maintain growth throughout the growing season.
- b. Dormant scions have half the mold problems of greenwood scions.
- c. The bleeding associated with walnut and hickory species is minimized by waiting until late May, the season for grafting on greenwood. Leaves are retained below the union, dissipating moisture.

15. **Dormant on Greenwood Grafting** disadvantages:

- a. Scion wood has to be taken during full dormancy, and stored for months, and retain full dormancy.
- b. Persian walnut scion wood has to be taken in fall before winter injury, and grafting this late works infrequently due to the stunting of new Persian growth by insects.

16. **Dormant on Greenwood Grafting** materials:

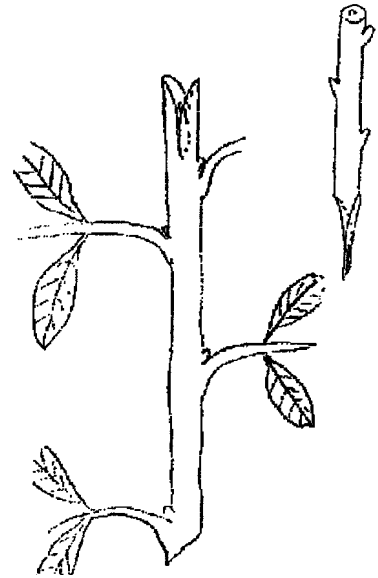
- a. Root stocks have spike growth nearly 1 cm. in diameter and wood fiber forming at the fourth leaf node. The green wood is more wood than celery so it does not shrink with water loss. The pith at the union near the fourth leaf node is gelatinous and not separated.
- b. Waxed scions cut to length, 4 in./10 cm. typically, with two or three fully dormant buds, one bud near the top.
- c. Grafting kit: sharp pointed knife, pruning shear, Teflon, masking tape, or Blenderm, clear first aid film, extra heavy duty aluminum foil, pencil, labels.

17. **Dormant on Greenwood** Grafting method:

- a. After weeks of warm weather check the spikes of new growth on walnut and hickory species to find woody shoots forming woody growth near the fourth leaf node.
- b. Match the scion to the stock at about the fourth leaf node. Clip off the top of the stock with a horizontal cut at the top of the union. The leaves below are to be retained permanently, but no new growths.
- c. Cut a 4 cm. notch in the top of the greenwood stock for an inverted saddle graft. In one "saw" stroke cut horizontally, then down, from the cambium in one curving cut 2/3 the way to the opposite side. Reverse the knife to pierce in and up from the bottom of the first cut. In one "saw" stroke cut vertically then to the side to exit on the opposite side from the first cut. Later, remove the cusp of greenwood from the notch.
- d. Similarly point the scion to fit the notch. Cambium should press cambium on all sides.
- e. Wrap the entire union with a vapor tight seal of Teflon. Draw tight, to the pull Teflon toward being a string, but widen it again with a finger tip, and continue spiraling it up past the ribs. Callusing will stretch the Teflon, weld it, but right now clamp the last turn with masking tape.
- f. Wrap a two ply cylinder of aluminum foil about the scion, from above the lowest bud, to 1 in./3 cm. above the top of the scion. Crimp the foil against the scion. Do not crimp the top of the cylinder, but flatten it for easy opening by the flushing scion.
- g. Clip the shoots which grow from the stock's leaf axils as they extend.
- i. In the fourth week after grafting, and growth ballooning the foil, it is time to remove the foil.
- j. Remove sprouts from the stock as they appear, but not the mature leaves.

18. **Greenwood on Greenwood Grafting** advantages:

- a. Scions can be gathered the day of grafting. However, start a week ahead by spraying scions and stocks with copper blight spray.
- b. Winter injured scions, and long storage common with Persian walnut are eliminated.
- c. Carbohydrate manufacturing leaves are retained on the stock to maintain growth throughout the growing season.



19. Greenwood on Greenwood Grafting disadvantages:

a. This is mainly a method to gain a few Persian walnut trees. Take advantage of copper blight spraying to get blight off scions and stocks a week before grafting. Do not delay because Persians, which go into second growth late in the season, stand up to pests, and winter injury least well.

b. The blight already started in greenwood scions often takes control.

c. Scions have to be sent by overnight mail.

20. Greenwood on Greenwood Grafting materials:

a. Scions are 3/8 in./1.5 cm. diameter rapidly growing terminals.

b. Stocks have 3/8 in./1.5 cm. diameter rapidly growing terminals. Wood fiber is forming at the fourth leaf node. The pith at the fourth leaf node remains gelatinous, not separated.

c. Grafting kit: sharp pointed knife, Teflon, sticky tape, tops of last year's goldenrod cut to match 10 in./25 cm. high hat trees, clear first aid film, clear or plastic double wall freezer bags, twist ties, aerosol can of white paint, pencil, labels.

21. **Greenwood on Greenwood** Grafting method:

a. In late May check the spikes of new growth on to find wood fiber forming near the fourth leaf node.

b. Match the scion to the stock at about the fourth leaf node. Clip off the top of the stock with a horizontal cut at what will be the top of the union. The leaves below are to be retained permanently.

c. Clip the scion to two leaf nodes with **leaf** buds and partial petioles. (An option is to use the flushing terminal of the scion stick.)

d. Cut a 1.5 in./4 cm. cusp in the top of the greenwood stock for an inverted saddle graft. In one "saw" stroke cut horizontally, then curve down, from the cambium on one side to mid scion. Reverse the knife to pierce in and up from the bottom of the first cut. In one "saw" stroke cut vertically, then to the side, to exit at the side opposite the first cut. This should free the cusp of greenwood in the notch, a temporary plug.

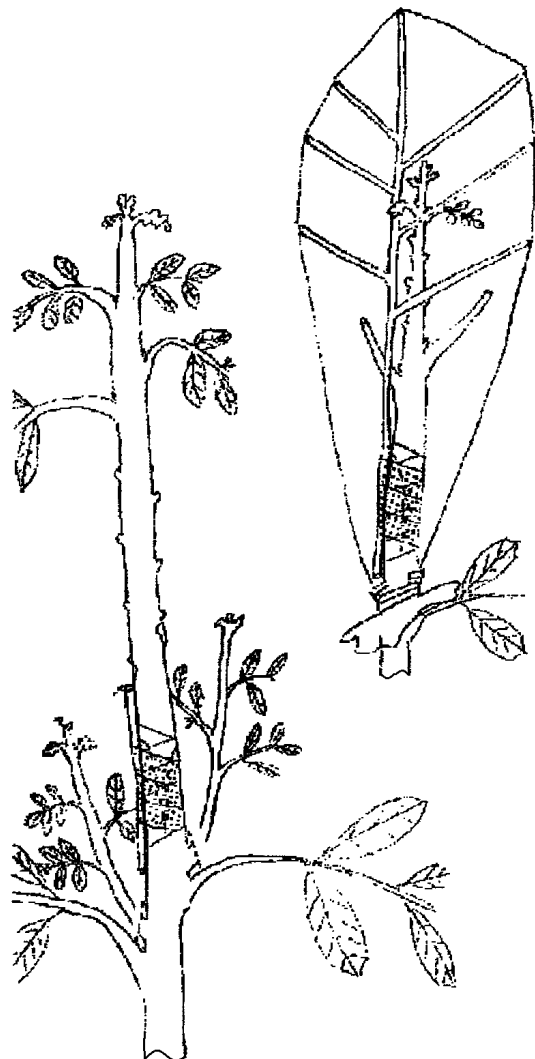
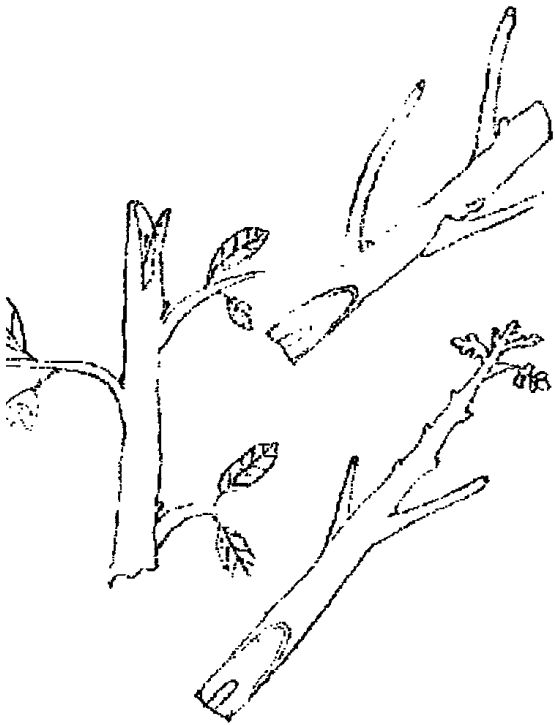
e. Similarly point the scion to fit the notch. Cambium should press cambium on all sides.

f. Wrap the entire union with a vapor tight seal of Teflon, spiraling up from base to nibs of the union. Draw tight, to the pull the Teflon almost to a string, but re-widen the Teflon with a finger tip until the nibs are sealed. Tie the nibs with a clamp of masking tape.

g. Bind the stalk of golden rod to the stock with masking tape to act as a bag spreader around the scion.

h. Fit the freezer bag over the weed stalk. Twist-tie the bag to the stock 1.5 in./3 cm. below the union by spiraling on a double twist tie, and masking tape.

i. Spray the bag with a bit of white paint on the top and south side to reflect direct sun. Use the unpainted side of the bag to inspect growth.



j. Inspect the grafts at weekly intervals, and after thunderstorms to tighten bags, and dump water. Remove stock sprouts from the leaf axils as they reach 3 in./8 cm. long. Remove sloughed leaves and petioles from in the bag. Repair bag with weatherproof Elmer's glue, or masking tape.

k. At the end of the fourth week, or when the leaf axil sprouts on the stock reach 3 in./8 cm. the second time, or when the graft grows 4 cm., it is time to remove the bag.

(1) Remove sprouts from the stock as they appear.

22. June Greenwood Persian Budding advantages:

a. Bud sticks can be gathered the day of budding, or stored in a cooler or a few days. A copper blight spray should be applied to stock and scion about a week before taking.

b. Winter injured scions and long storage common with Persian walnut are eliminated.

c. Scarce material is conveniently multiplied.

23. June Greenwood Budding disadvantages:

a. Blights already started on greenwood often takes control.

b. The union cannot always be sealed tight, and pockets of moisture can be trapped to ferment the union.

c. Bud sticks have to be sent by overnight mail.

d. Persian walnut buds which do not grow a bit after knitting will often winter kill. Those which bolt die back, but often survive.

e. Try to bud in the early morning of an overcast day, minimizing the chance of direct sun on the wood, wind, and body sweat injury on the wood.

24. June Greenwood Budding materials:

a. 2 in./5 cm. diameter rootstocks of black or Persian walnut.

b. Persian 5/8 in. /2 cm. diameter terminal growth.

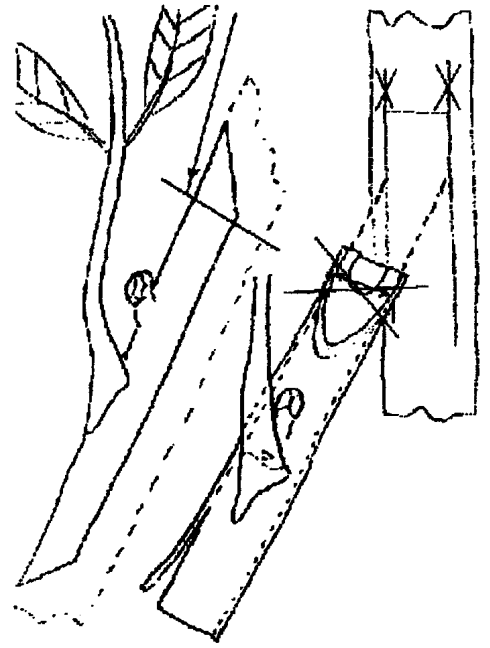
c. Budding kit: knife, Teflon, plastic strips or thin rubber inner tube strips, 2 liter clear plastic food storage bags or plastic food film, pencil, labels. Carry a moist, chlorinated towel to keep hands clean, Instaflex joint support taken as directed before bending back.

25. **June Greenwood Budding:** H budding method is shown left... T budding is described. (Also see PERSIAN WALNUT 76.)

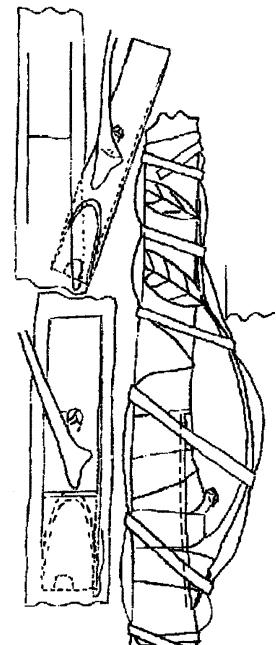
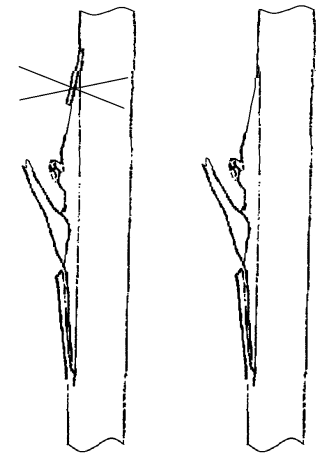
a. Bud into June as long as bark is slipping, and the pitch under the bud is gelatinous, not separated. Choose a plump leaf bud. Trim the leaf stalk to a manageable two or four leaflets. Persian walnut leaf buds look like tiny cabbages, while catkin buds look like tiny pine cones, and must be avoided/stripped.

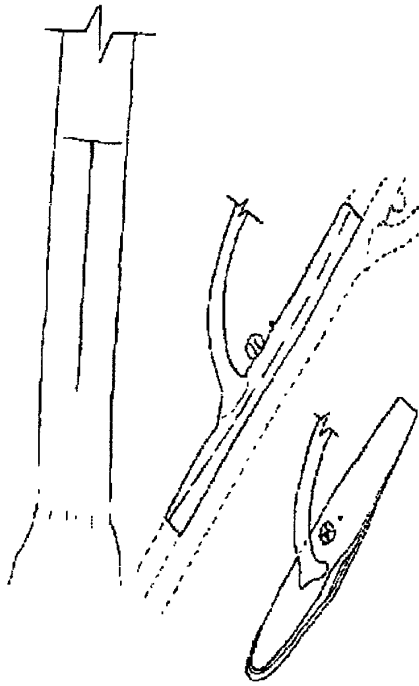
b. Cut a bud chip extending from 3 cm. above the bud, down the center of the stick, and out 3 cm. below the bud and petiole. Hold the chip mainly by the petiole. Shave off pith until the underside of the shield is mainly wood.

c. Looking at the bud side of this wedge, gauge a uniform width from side to side. Cut feathers of bark off each side beside the bud to give the shield uniform width. Cut this width into the bark of the stock, forming an H where the bud will be centered.

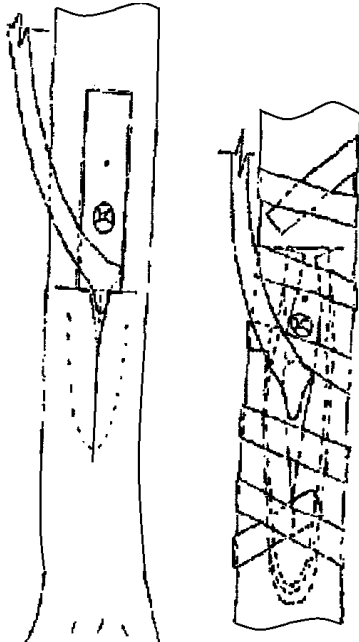


SLIPPING THE WEDGE TOP OF THE GREEN WOOD BUD UNDER A FLAP OF BARK MIGHT WORK, BUT BARK ON THE STOCK HAS TO BE REAL SLIPPY, BUT NOT WEEPY. (NOT SO MUCH IN THE WAY)





- d. Lift the flaps (tabs) of stock bark "T" a bit to note bark slipping. Cut a long wedge of bark off the bud shield, below the petiole, trying to expose a bit of cambium to mate the lower flap of the "T". The bud chip will move under the bark of this flap. Press these tabs several times to get them moving, but do not peel them back.
- e. Slide the bud shield under the lower tabs of the "T," using it in a rocking motion to pry up the bark as it slides.
- f. Cut the shoulder flaps of the "T" to expose the bud, and lay them against its shaved sides. The bottom flap was raised by sliding and should need a little trimming to expose the bud, and maybe cutting and bark removal above, if the bark is easily yielding, to incise the top of the shield. If the stock's bark at the top of the shield does not pick up, or does not need to, sever the top of the shield. Use the same knife cut to cut the top shield and flap, and pick out enough flap for incising "T" shield size, making a snug fit. (This modifies typical H budding to eliminate counter productive repositioning, and flipping bark for shield insertion.)
- g. Tape the union with Teflon leaving the bud and leaf protruding.
- h. Insert the leaf into a food storage bag and draw the mouth around the budding area. Embrace the stock with the leaflets. Seal the bag against the stock with the rubber strips at slight extension.
- i. After one week break over the top of the seedling stock.
- j. Inspect after rains to dump water and remove sloughed leaf parts. Remove bags after 4th week if the leaf sloughs, or after the bud grows leaves.
- k. Cut back the stock the following spring.



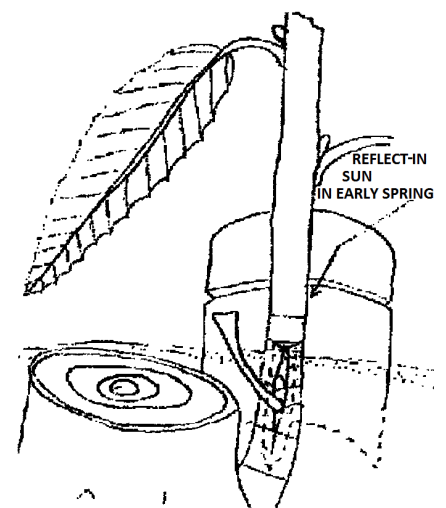
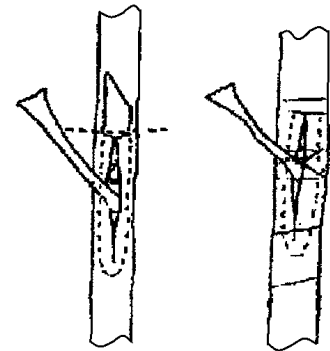
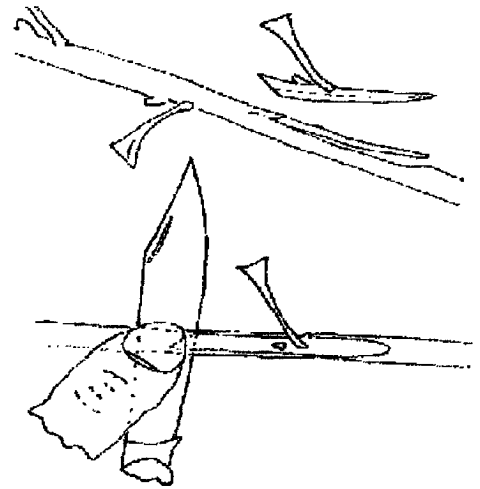
26. **Slip Budding Advantages:**
 - a. Fruit species will slip bud through August whenever the bark is made to slip by heavy watering.
 - b. Slip buds establish close-enough union immediately to furnish moisture for transpiration.
 - c. Many reproductions are possible from a few bud sticks.
 - d. Root stocks can be small and young, easy to dig and ship.
 - e. Cambiums are overlain so that your eyes do not get strained trying to match cambial lines.
 - f. Skill at slip (sliding under to release bark and seat the bud) budding applies to bark grafting, and "H" and "T" budding by the need to raise slipping stock bark, and pressing in the bud shield below where the bark was lifted by the knife.
27. **Slip Budding disadvantages:**
 - a. People unfamiliar with cambium sensitivity, open the cambium to air and sun, killing it. Slip budding is best done with three people; one trained in slitting bark and pushing in buds, and two people binding.
 - b. Nut species are seldom completely slip budded due to their large awkward barks, and bud shields, but partial slipping under shield pressure is good enough.

28. Slip budding materials:

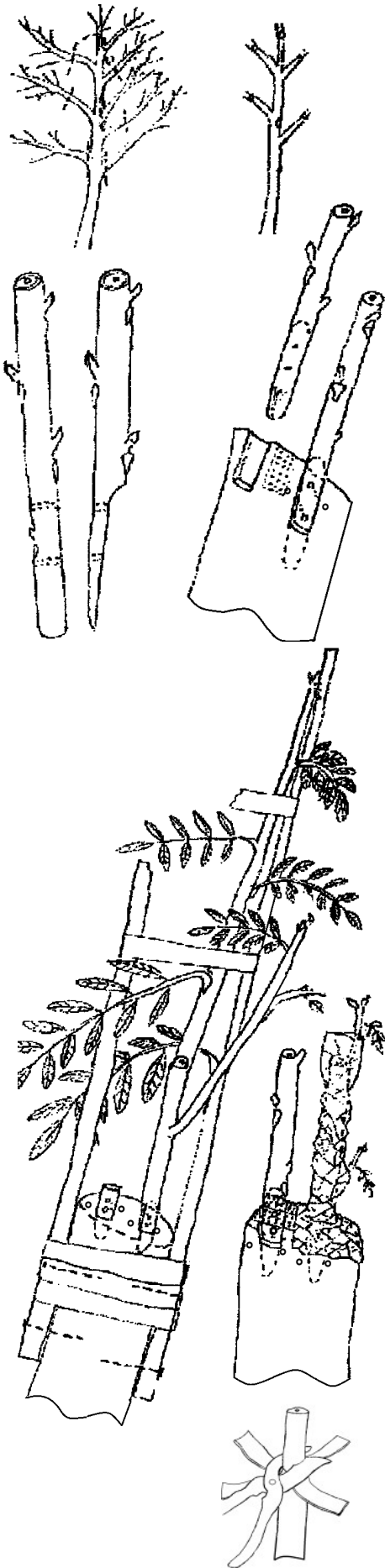
- a. 1 in./2 cm. diameter, and above, young stocks with smooth, thin bark which is slipping.
- b. Bud sticks with slipping bark, and trimmed to petioles with a bit of leaf.
- c. Budding kit: knife, clear plastic strips or Teflon, pencil, labels, Instaflex joint support taken per directions before bending back.

29. **Slip Budding** - T budding method:

- a. Soak the soil of the rootstock throughout the root zone within a week of slip budding.
- b. Gather terminals or sprouts from selections which have grown rapidly. Retain partial leaves and all the petiole. These are wrapped in moist toweling for storage in a cooler, or sending in overnight mail, then soaking in warm water overnight to get bark slipping for budding the next day.
- c. When the bark on the bud stick and rootstock slip, cut a "T" in the bark of the stock, 3/8 in/0.7 cm. cap and 1 cm. leg. Lift a tab of bark only enough to check slipping and replace. If the bark does not release easily from a wet cambium, move on to another stock, apply more water.
- d. Remove a bud shield from a bud stick. Do not tear the bark; do not completely sever the bud wood chip from the stick; and do not touch the cambium with a finger, though it may be held moist in humid mouth air while pressing/rubbing the "T" to insure flaps come free. Cut upward from 1.5 cm. below the bud, 1 mm. below the wood, until well above the bud. Withdraw the knife without severing the wood chip. Sever the bark 0.5 cm. above the bud, raising this end of the bud shield onto the knife where it is clamped with the thumb. Twisting and shoving the top of the shield, wipe it off the chip, retaining the plug of pitch beneath the bud by a shearing motion.
- e. Insert the bud shield into the top of the stem of the "T" cut in the stock. Grasp the base of the leaf petiole, using it as a handle. Work the shield lower than the bottom of the "T". Leave it thus seated.
- f. Cut the top flap off the bud shield. Gauge this with the cap so cutting seats the shield snugly in the "T".
- g. Wrap the cut area with Teflon, tie with a clamp of masking tape.
- h. In the second week after budding, break over the top of the seedling stock.
- i. If the slip budding was done in June, sever the stock just above the bud after the third week. Cover the wound with aluminum foil, or seal it with Elmer's Glue. If the budding was done May/June, sever top. July through September, leave the top to be cut next April, then seal with Elmer's Glue.
- j. Stake and tie the rapidly growing shoot. This is especially important if the stock is much thicker than the shoot.



Chestnut budded at ground level to attempt rooting.



30. **Bark Grafting advantages:**

- a. Pecan, water activated scions, cut in late March for usual dormant grafting, which can transfer moisture through patching cambium to cambium.
- b. Larger trees can be top-worked with the fewest scions, but done north of Maryland, recovery of stock and grafts for winter is poor.

31. **Bark Grafting disadvantages:**

- a. Works best with pecan due to healthy, disease resistant bark.
- b. Stocks are large compared to scions, requiring cutting back two weeks before grafting, and the discontinuity of large stock to small scion needs staking and healing treatment for several years. Ford Wilkinson specialized in bark grafting the very tops of Ohio Valley pecans to Major pecan, and very few failed.

32. **Bark Grafting materials:**

- a. Large stocks cut back two weeks before grafting.
- b. 1 to 2 cm. diameter scions with holes drilled in bases for nailing, and all wounds sealed with Tacky or Elmer's Glue.
- c. Grafting kit: pruning saw, knife, 2.5 cm. flat head wire brads, tack hammer, clear first aid film, Tacky glue or pitch type wound dressing, extra heavy aluminum foil, letter stapler, pencil, labels.

33. **Bark Grafting method:**

- a. As the cut off stocks start to regenerate buds, rub these buds off, and bark grafting can begin. Cut slopes on the branch stubs to ease the discontinuity from stock to scion, easing healing and binding.
- b. Soak scions a day, and a night. Point the scions by taking a 2 in./5 cm. wood chip from its base.
- c. Match the scion to where it will seat flat against the stock and mark its outline.
- d. Holding the scion in your teeth, so your breath can condense on the cut, remove the top 3 cm. of bark from the scion seat. Push the bark at the base of scion seat back and forth to moisten/prepare the bark of the stock to ease its raising by the scion.
- e. Cut long thin wedges of bark from the margins of the scion base to butt cambium against the stock's inner bark. Shave bark off the wedge point of the scion, uncovering cambium to be united below the bark of the point of the scion.
- f. Shove the scion 1.5 cm. under the bark low on the union.
- g. Nail the scion to the stock.
- h. At this point the slave that started the grafting of Stuart pecan bound Mississippi clay/tallow mix against the wound of the union. These days, it is easy to dab on Elmer's Glue, then bind on a similar wound dressing.
- i. Crimp and fold aluminum foil against scions so they push open the foil.
- j. Inspect the stock at two week intervals to remove shoots.
- k. Brace extensive growth against windstorms.

34. **Flap Bark Graft - see Pecan pg. 97**

BREEDING...

CONTROLLED POLLINATION, OPEN FIELD POLLINATION, & SELFING, IN LINE BREEDING, STRAIN, CROSS, HYBRID

1. Plant breeder's philosophy: Plants respond to a changing world by semi-random variation. If the grower knows what to look for, he can direct reproduction toward improvement.

A. The great problems of the tree breeder are:

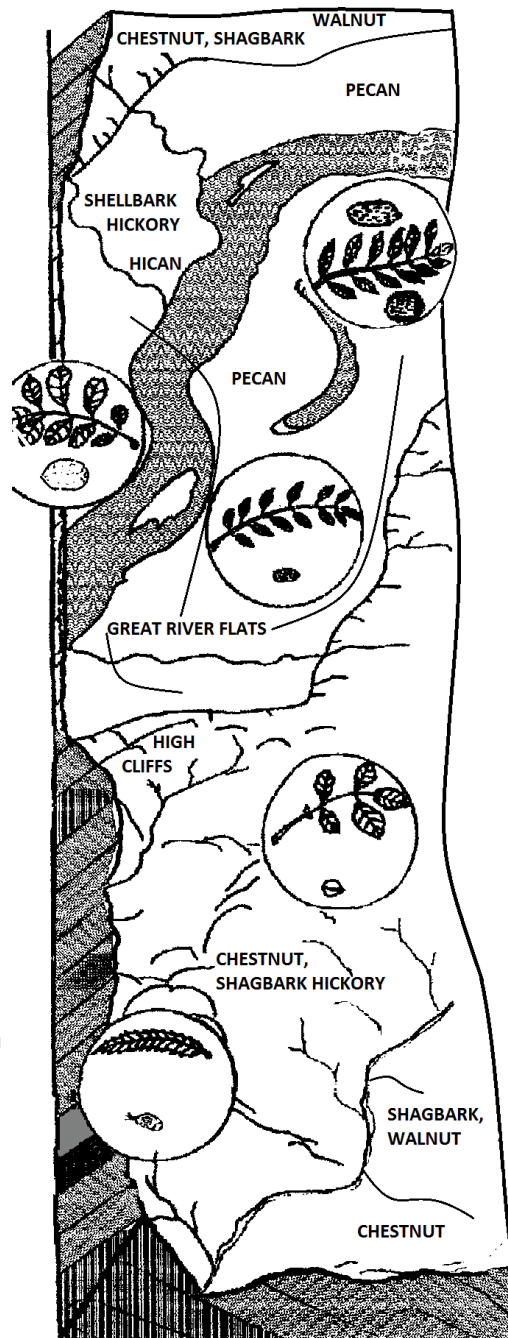
1. Trees are out pollinators, and hold more diversity than the breeder knows what to do with.
2. Turnover time is longer than most breeders can sustain interest.
3. Trees are large. Real estate is expensive. Replication of one strain is not enough for sustained improvement.
4. The final test of a nut, or fruit tree is at maturity, some tens of years after bearing begins. Branchlets, buds, and leaves change with growth stage: Vegetative...Fruiting...Mature stage.
5. We get the advice on breeding lines from the institutional breeders: "Keep 60 lines in the breeding program." My first reaction is, "Don't tell me, show me, not with apples, but with nuts". This admonition to keep 60 lines going may sound simple though no one seems willing. Have dreams about lines following Emma K black walnut, Sauber black walnut, or Geneva Long persimmon, Geneva Red persimmon. The admonition sounds correct because it sounds like nature's way, serving animals more than humans.

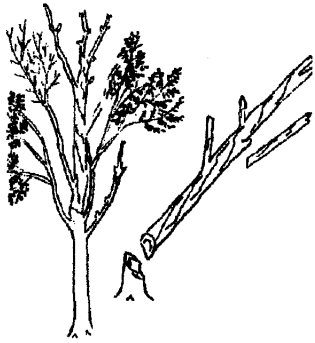
B. Aids to the tree breeder are:

1. When mother tree produces healthy seedlings, they and their nuts are 80% reproductions of herself, not 50% as father nut wanted, maybe.
2. The mother tree controls most of the processes in reproduction, contributing the cell structure, and polar body heredity, plus half the chromosomes, and most of the ways chromosomes fold.
3. Good trees can be reproduced by grafting, isolated, and open pollinated.
4. Nature, seedling growers, and growers of selections have grown out many trees, which await observation, and selection.
5. Good trees are a joy to observe. They have fingerprints of fruitfulness.
6. Traits which come with maturity are linked with juvenile traits. Seedlings show they are candidates for saving, then prove it in bearing.
7. Bud mutations often grow into sport branches, yielding variation in line, like selfing. Genetic engineering is in line, like selfing.
8. Production, the trait most important to the grower, accumulates steadily with breeding until the tree frame is found inadequate.

C. Trees have endured because:

1. The variability in a stand must match gradual change in the environment, which crowds out unfit siblings.
2. Select trees endure stress with little reduction in population. Stress like:
 - a. Erratic growing season.
 - b. Defoliation.
 - c. Loss of leader.
 - d. Loss of top, if regenerated from roots or root crown.
3. Strains adapt to their site, breeding to hold it, often becoming dependent on it.



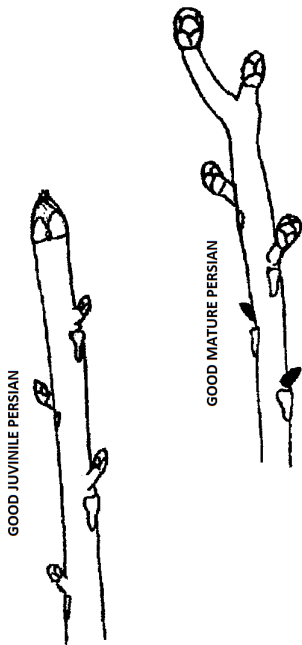


- D. Blockages to tree propagation:
1. Destruction in one, or a few generations, due to:
 - a. An imported disease or insect.
 - b. Loss of site conditions.
 - c. Loss of breeding partners.
 - d. Transportation to a site beyond adaptation.
 2. Having to screen trees in the wild rather than under cultivation.
 3. Having to screen juvenile trees for mature traits.
- E. Possible role of the grower in breeding:
1. Gather selections.
 2. Isolate breeding partners.
 3. Grow seedlings.
 4. Screen seedlings.
- II. Husbandry is the 19th century term for raising crops. Husbandry remains a descriptive term for the close care and observation needed in controlled breeding. To grow nuts and fruit profitably we must nurture them, and genetically improve them.

A. Selecting and rejecting breeding partners is the bulk of what breeders do. For plants to express traits, the traits must be in the plants genes and adapted to the culture provided. The desired trait must be there to be passed to the next generation. We either observe the desired trait in the breeding partners, or know it lays hidden in the strain. An example is Manregian walnut which tends to bear on the side buds of the previous year's growth, which are 99.99% vegetative in other Persians. Thus, we breed with that strain to increase production. Buds on stalks have flowers, thus save seedlings with buds on stalks. I see CW3 heartnut side bearing, but only when a hard freeze takes terminal growth.

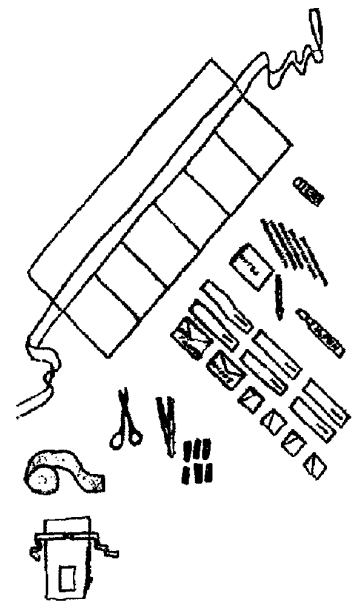
B. Certain genetic traits, are passed from generation to generation linked with other genetic traits. This happens because chromosomes which contain the genes, which often pass as a unit from generation to generation. Each chromosome contains a multitude of genes. For example, the gene (or group of genes) that control early ripening are looked for in seedlings by noting their link with the visible juvenile traits of early sizing of leaves, and quick, early in the season turn to dark green. One link with production seems to be large side buds which extend out of leaf axils on bud stalks. We cannot afford the growing out of the whole spectrum of seedlings, or even those most healthy.

C. Selections out of the wild are nature's gifts in establishing hardy nut crops. In nature one seed in a million becomes a tree. Far northern pecans from the latitude of Chicago, exceptional black walnuts from the central divide of Ohio, and high quality shagbark and shellbark hickories from near Sarnia, Ontario, and the Wapsipinicon delta in Iowa are starting domestication. These acquisitions sometimes have production on smaller, younger trees, but both good, and bad orchard traits are expected straight from nature. The Fritz pecan, or Starking Hardy Giant pecan are unbeatable when reproduced in their own native groves. Bring them to an orchard with Colby and similar Ohio Valley selections and they lose rating. This fizzle in seedlings is so typical of trees from the wild that until culture and breeding improves we may not be able to evaluate their strengths. The groves of Posey, Major, S-24, Gibson, and Fritz gathering have provided seedlings, which give just a glimmer of the expected progeny here in Niagara. We do well if the tree stature matches, either as grafts, or seedlings from brought back seed.



III. Controlled pollination kit:

- A. Compartmentalized apron, carpenter's apron, or ammunition belt, manicure scissors and eyelash tongs, or tweezers, paper bags, or breeder's bags which are water resisting and have a view window.
- B. Small glassine envelopes sized 55 mm. by 85 mm. and 80 mm. by 125 mm. flap on long side, some labeled (containing pollen), most cut in half through flap, ready for enclosing bloom.
- C. Paper clips, string, twist ties, and gauze.
- D. Tags, or strips of file paper cut with an eye end for making hanging tags.
- E. Nursery pen, or grease pencil, especially the soft lead pencil with pool liner plastic tags for more permanent tags.
- F. Note pad and pencil.
- G. Pipe cleaners, small artist's brush, glass rod, or lead pencil with new rubber eraser, rubber bulb pipet, vials of pollen.
- H. Medicine bottle with rubbing alcohol, and dipped swabs for sterilizing equipment.



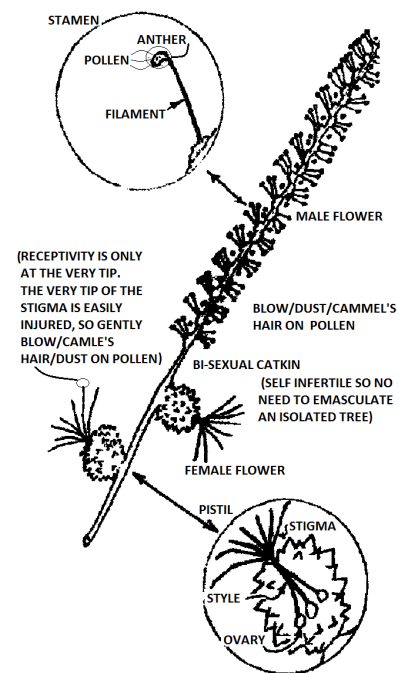
IV. Pollen collection:

A. Pollen is mature and free to move as when it easily dusts off of male flowers. The trick is to find a collection method that gathers mature, viable and free-to-disperse pollen which is free of contamination by stray pollen. We try to reproduce the conditions of natural pollen maturation, but in isolation. Nature's way is to shed pollen abundantly from exposed male flowers as the sun evaporates off dew, and the wind begins to stir on a very warm, very humid morning.

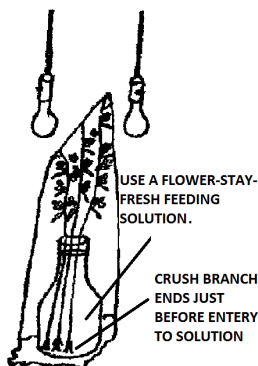
1. Chestnut pollen, which is considered to be insect distributed, will disperse in a breeze under the above conditions. Most often chestnut pollen is difficult to make free because it is sticky. Rain and high humidity cause it to cake and remain unusable for pollination, even with no shelf life due to humidity causing it to grow. Taking chestnut catkins in a two hour trip from one tree to another in a plastic bag has produced seed because branchlets/catkins have two hour pollen life. If set in a vase with flower-stay-fresh solution have days of pollen life...these catkins taken to oven drying/sieving/freezing have year long storage. With no care of pollen, germination tests show 30% strong germination at 4 hours, 5% germination in one day. Strong germination can be maintained for at least a week if a vase of branchlets with shedding catkins is kept topped up with water containing flower-stay-fresh sold by garden shops, then hung in a tree

B. Pollen, which is soon to be contaminated, is harvested by removing branchlets and maintaining them under greenhouse conditions. Set in a warm oven, the pollen is collected as it matures by tapping or vibrating it onto a glass plate. A few hours of warmth and drying are needed to stop germination temporarily. The pollen is scraped with a razor blade into a glassine envelope, or vial. Storage is in a freezer. Store with calcium chloride granule packets in a sealed glass jar. Such storage maintains 40% relative humidity, 20°F/-29°C.

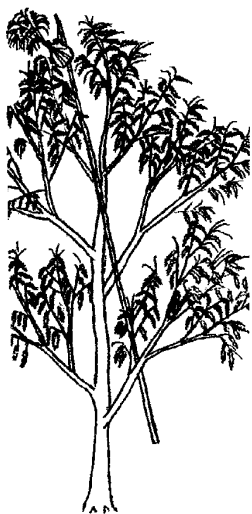
V. Pollination occurs when pollen contacts the moist and sticky stigma tip of the female flower, germinates, and causes a pollen tube with the male germ cells to invade to female germ cells in the ovum where germ cells unite to 2n, full chromosome number. Processing pollen is matched in an orchard by the whole insect army moves to overpopulate flowers with pollen for survival of the fittest. The pollen grains germinate before rain washes them off, or the stigma dries. Controlled breeding must insure that mainly the pollen from the desired breeding partner contacts the stigma, and fertilizes the ovum. Perfect flowers contain a male part, the stamen, and a female part, the pistil over the ovum. If the flower is sheathed, the



apricot type flower can be pulled off for hand pollination. This emasculation denies self pollination, and hand pollination is in isolation with only the introduced male pollen. Un-sheathed flowers require bagging before undesired pollen is abroad. Although the stigma may be greenish and dry, indicating it is not yet receptive, applying the pollen and enveloping the pistillate flower will keep pollen viable for a short period until the stigma becomes receptive. Bags are only slit or temporarily removed to introduce pollen, then taped or replaced, for several days incubation until stigmas tan and dry. Un-open chestnut and filbert catkins need **not** be removed from isolation bags because they rarely use self pollen (5%), or hold stray.

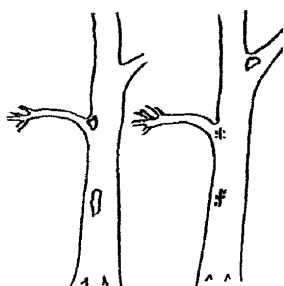


1. Pollen maturation under greenhouse conditions on vased staminate: Remove the staminate branchlet to isolation before contaminated by stray pollen. Smash the base of the stem with a hammer and immediately vase in water containing flower-stay-fresh. Bag the branchlet in plastic to prevent mature staminate from drying. With food, humidity, and light as at 20 cm. from a 100 watt bulb, the branchlet should continue to function and mature pollen. As the pollen matures it may be tapped off and stored. Be careful not to get it wet, or it will germinate, or become caked and useless. Pollen ripening is hastened by greenhouse conditions. As staminate mature they can be used directly to pollinate early flowering selections. Branchlets from isolated trees are vased using flower-stay-fresh, and plastic bagged at the tree for transportation.



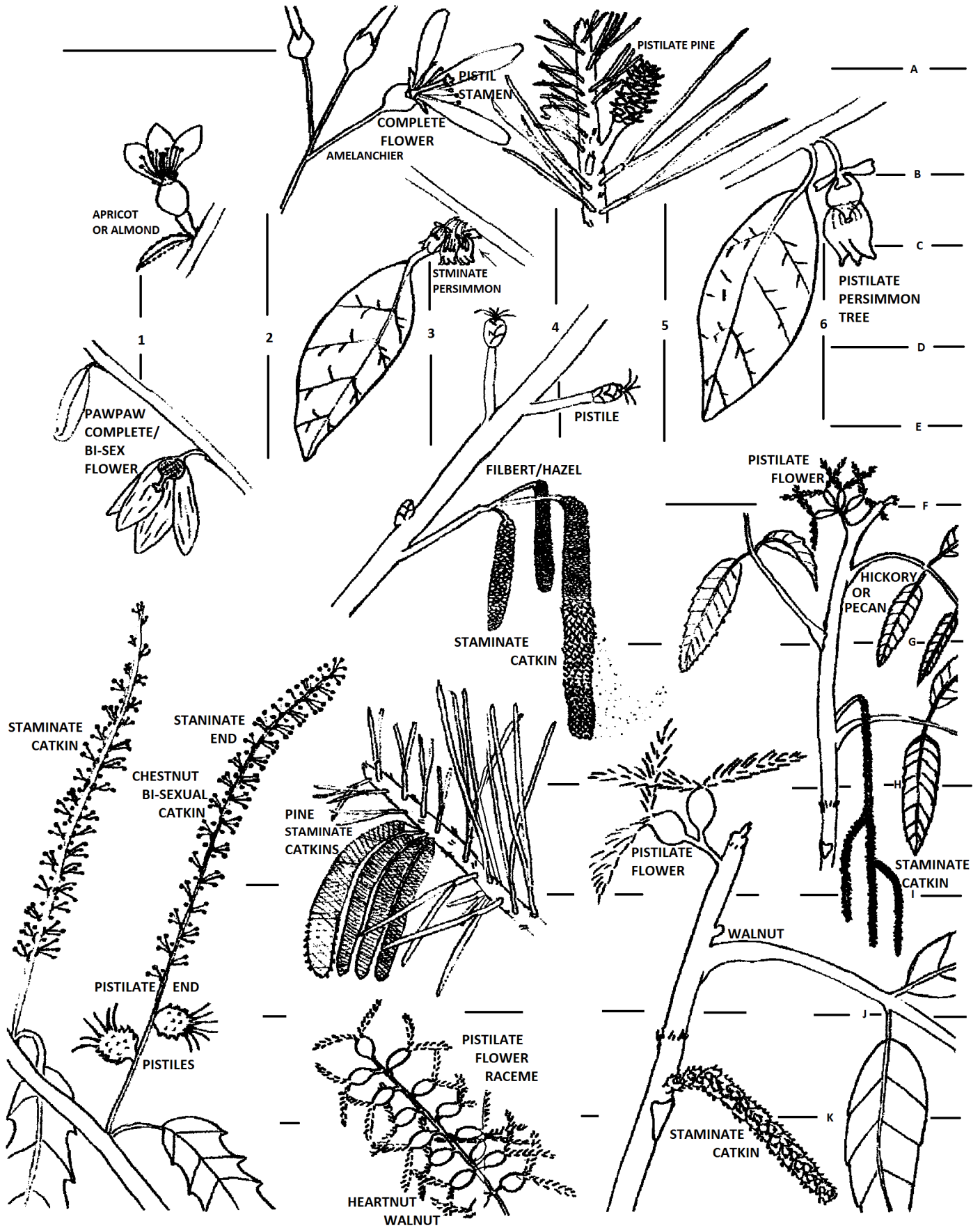
2. Pollination of isolated American chestnut trees by hand is twice difficult due to easily damaged pistils which must be gently touched on their tips with pollen, and trying to work on bloom in the top of a large tree. Previous attempts at hand pollinating have yielded few nuts because of improper conditions handling pollen, time injured/germinated catkin pollen, and roughly rubbing the catkins on the pistillates, injuring their tips. Herb Darling is a Buffalo native, and president of the New York Chapter of the American Chestnut Foundation who pollinated large isolated natives to produce seedlings, thus saving large local trees for one more generation of breeding. Blight resistance is being introduced to these timber trees, through genetically engineered breeding partners which are currently being assembled by Professors Charles Maynard and William Powell at the College of Environmental Science and Forestry at Syracuse University. The first of these engineered chestnuts are in test plantings in NY, very much in thanks to Herb. Herb has produced hundreds of seed from previously barren trees by hanging vased catkins in large trees. These catkins would die in a few hours if only vased in water. By adding flower-stay-fresh to the water a vase of catkins can be kept alive and attractive to bees for about as long as the water solution lasts. A plastic 2 liter soda bottle is usually good for four days until the water reservoir drains.

a. American chestnut continues as a forest tree, but barely. Herb has been spotted large chestnut from airplane as they flower in early July. This works if the chestnut is heavily in bloom, but the chestnut is not visible if bloom is light as in a younger tree. Light bloomers need to be walked down by smelling chestnut, and finding last year's burs on the ground.



b. You would think that after re-sprouting and standing against the blight for near a century these large chestnuts would endure for the tens of years needed to engineer a breeding partner. Typically, mature chestnuts are suffering from blight infection with only have a year or two of bearing left (mainly dying from drought, or one last bumper crop). If today they produce seed, there are plenty of people, and plantings willing to grow it. We can get another generation out of them, but we also must fund laboratory work to continue recent progress in implanting gene modified (GM) packets of inheritable resistance as donated by blight fungus resistant genes from other human-food plants.

c. The existence of large chestnut trees today is not an indication that the species of trees is changing to blight resistance to coexist. The blight is still winning. Mainly, an infected tree can only withstand recent severe droughts if near a permanent spring.

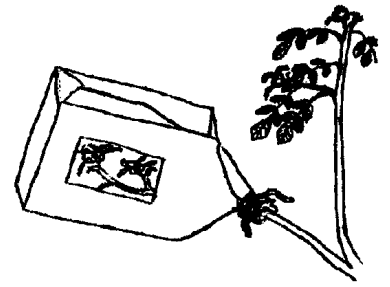


SPECIES	MALE FLOWER	FEMALE FLOWER	METHOD OF POLLEN COLLECTION		METHOD OF POLINATION
			KEYED TO TABLE BELOW		
FILBERT	4F	4D	2A	3A 4A, B	1B, C, D 2C 3C
AMELANCHIER	3A PERFECT FLOWER	3A	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
ALMOND	1B COMPLETE/PERFECT	1B	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
APRICOT	1B COMPLETE/PERFECT	1B	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
CORNELIAN CHERRY	1B COMPLETE/PERFECT	1B	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
AUTUMN OLIVE	1B COMPLETE/PERFECT	1B	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
BEECH	1H	2J	2A	4A, B	1B, C, D 2C
KIWI	1B COMPLETE/PERFECT	3B	2A	3A 4A, B	1A, B, C, D 2C, D 3C, D
PAWPAW	1F SELDOM COMPLETE	1F	2A	3A 4A, B	1B, C, D 2B, C, D 3B, C, D
NUT PINE	6K	6F	2A	4A, B	1B, C, D 2C
BLACK WALNUT	5K	5H	2A	4A, B	1B, C, D 2B, C
BUTTERNUT	5K	5H	2A	4A, B	1B, C, D 2B, C
HEARTNUT	5K	3K	2A	4A, B	1B, C, D 2B, C
PERSIAN WALNUT	5K	5H	2A	4A, B	1B, C, D 2B, C
HICKORY	5K	6F	2A	4A, B	1B, C, D 2B, C
PECAN	5K	6F	2A	4A, B	1B, C, D 2B, C
MULBERRY	1B SELDOM COMPLETE	3A	2A	4A, B	1A, B, C, D 2B, C
PERSIMMON	3C SELDOM COMPLETE	6C	2A	3A 4A, B	1A, B, C, D 2C, D 3C, D
SWEET CHESTNUT	1H	2J	2A	4A, B	1B, C, D 2C
ELDERBERRY	3A COMPLETE/PERFECT	3A	2A	3A 4A, B	1B, D 2C 3C

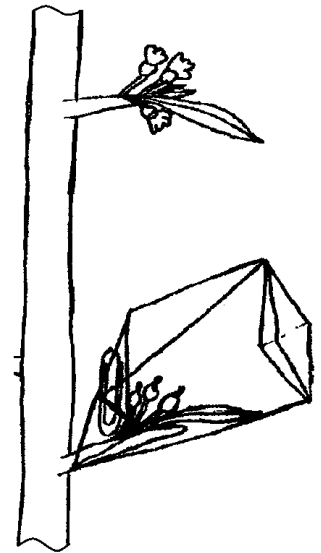
A. Schedule of controlled **breeding maneuvers:**

1. Plant the breeding selections in isolation.
 - a. Plant only female trees of a species, or pollen sterile trees like Layeroka chestnut and Weschcke hickory.
 - b. Plant breeding pairs in isolation, usually proven parents.
 - c. Graft branches of the desired pollen parents.
 - d. Hang or prop vased and shedding staminate in the tree tops for wind or insect pollination.
2. Bag flowering branchlets.
 - a. Collect dry, pure pollen by bagging before pollen maturation.
 - b. Emasculate female flower by removing staminate bloom/male pollen before bagging.
 - c. As (or just before) stigmas become sticky moist and white, yellow or red (indicating receptivity) open the bag and gently dab pollen with a glass rod/pencil eraser onto each stigma, or blow on.
 - d. Sheathed flowers may be bagged at the same time they are emasculated, and pollinated, provided they are about to open.
3. Tent the entire shrub with white plastic, or clear plastic which is painted white on surfaces toward full sun to isolate, and blow in pollen.
 - a, b, c, d, are similar to 2.a, b, c, d, above.
4. For pollen collection, gather staminate branchlets or flowers before contaminated by stray pollen.
 - a. Mature pollen under greenhouse conditions.
 - b. If grown in isolation, collect and use stamens as dabbing brushes. Unopened apricot or almond blossoms are often manually unsheathed and used as is. **Pawpaw** flowers seldom need isolation of either sex. You will likely never meet a vector. You will need to be gentle, recognize grey fluffy pollen, moist pistils.

5. Bagging pistillates, or staminate: Because brown paper bags disintegrate in wet weather, many people prefer special breeder's bags which are white, water resistant and have a view window especially useful in directing a puff of pollen squirted through a slit in the bag, and then taped. Gauze wrapped at the neck of the bag assures a tight, insect proof grab. Few, if any, leaves are removed because they are needed to nourish the seed and help spread the bag. Squirt once with insect spray at bagging.



6. Enveloping blossoms on spurs: Glassine envelopes which are cut in half can be clipped onto fruit spurs to isolate bloom. Dimple the hat end. Fold a diagonal tight to the spur. Clip the fold with a paper clip.

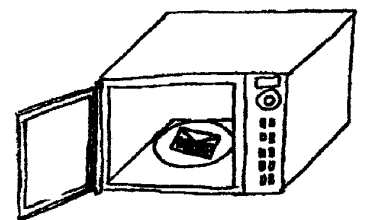


B. Inter Sterility: Chromosome pairing seeks uniformity, and should discourages exotics. Hicans/hickory-pecan crosses are exotics, and often misform, and are unproductive. Burton, Burlington, Henke, Des Moines, Girardi and Rockville are the exceptions. Persian walnut-black walnut hybrids are especially unproductive, even when producing a few worthwhile nuts. Nature permits variation within limits, but the abundant variation of hybrids is usually rejected, so expect applying undue effort. The rewards can be great enough to keep many breeders interested. However, there are stories of fights breaking out when a donor grower sends in pollen, and the breeder later finds how misshapen, misidentified, the donor's nut to be. Associations of nut growers should not be just social...be social, but verify. The hardiness of pecan has caused Russian and Chinese breeders to report hybrids with Persian walnut. Nuts of up to 25 in a cluster and 65% kernel are reported (not seen). Heartnut-butternut crosses exist which have the better disease resistance and shell structure of heartnut. Ability to pollinate a full cluster of even three nuts is rare. Crosses of native and oriental persimmon species are also "reported", but expect failures, and generations until production.

1. Persimmon breeding is blocked between oriental and our native. The chromosome count is the first block to check. The **Chromosome Atlas** lists both having $6n=90$. 15 is the n , basic number in the genus. The genus has many tropical species. Blocks against crossing may be; chromosomes breaking at a different node, oriental flowering before native, native ripening before oriental causing immature seeds to abort, pollen tube growing too slow or small, differing structure for seeds causing misshape split coats. Many cultivars of persimmon tend to be seedless under all conditions...Wabash/Evelyn. Looking at Geneva Long, maybe the cross has been made and not recognized, the female governing trait expression. American mother persimmon hybrids look/act like American persimmons, and oriental mother persimmon hybrids look/act like oriental persimmons, even the 160/180 day mismatched season that needs greenhouse breeding.

2. Filbert hybrids are now common, although difficult and rare at the turn of the century. After Jones matured European pollen and used it on native pistils, hybrids became common.

3. Chestnut is noted for its quality hybrids, but the initial pollination is rare. Gellatly, Etter, Graves, Douglass, Dunstan, Simpson and other chestnut breeders have made fine, productive crosses. This is surprising due to one Chinese chromosome being way longer than the American counterpart. Selection of good breeding material at the outset is witnessed in chestnut progeny. Many of the European hybrids are pollen sterile. Often 160 X 180 day hybrids fail in the Ontario/NY 160 day season.



a. Aids to difficult pollination:

(1) Aid pollen with growth promoting additives.

(a) 50% weak pollen from a female's species to trigger receptivity, + food.

(b) Powdered sucrose for food, about 5%.

(2) Fruit set sprays: (a) Gibberellic acid before or after pollination.

(b) .001% boric acid, pH 5.5, before pollination.

(c) Apple set, NAA, after pollination.

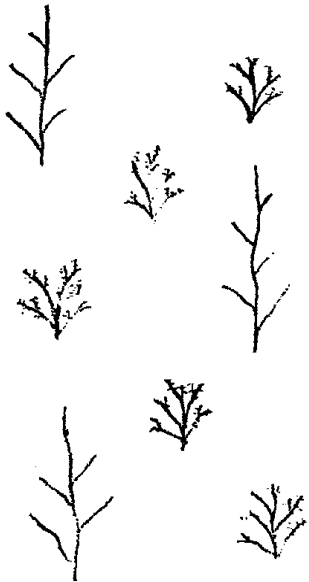
(3) The U.S. Agriculture Handbook #450, Seeds of Woody Plants in the United States, lists species and their pollen germination procedures. This book and reading the labels on flower set preparations are steps in the right direction. Rather than try chemicals and concentrations, it seems obvious that weakened pollen from the female parent's species will contain the trigger chemicals and nutrients required to set flowers. Kill this pollen without over-drying it: the least time in a microwave oven, less than toasting. The sterilized pollen should be used on some control flowers to check its sterility.

FILBERT/HAZEL HAVE $2n=22$ CHROMOSOMES & DISSOCIATE 11 CHROMOSOMES TO POPULATE THE SEX/GERM/SPORE CELL.
 SAY MALE SPERM: ABCDEFGHIJK EACH CODED WITH PETIDES/
 SAY FEMALE EGG: abcdefghijk PROTINES a, t, g, c

BRED FILBERT/HAZEL PLANT: $\begin{matrix} ABCDEFGHIJK \\ abcdefghijk \end{matrix}$
 ONE POSSIBLE BRED PLANT AFTER NEXT DISSOCIATION: $\begin{matrix} abCDefgHijK \\ LMNOPQRSTUW \end{matrix}$



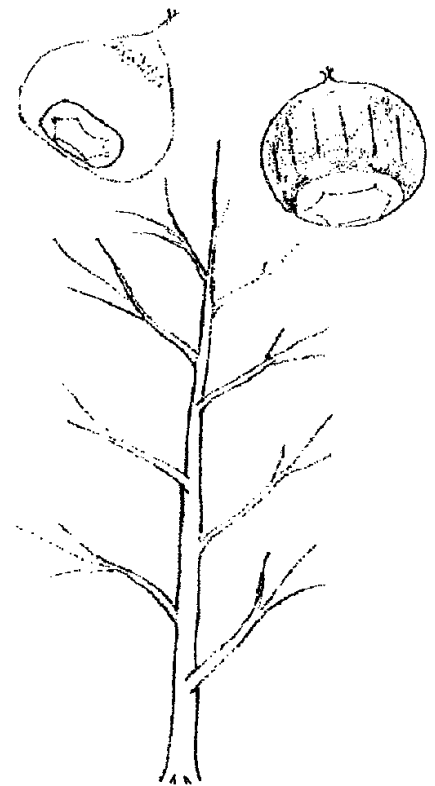
GCCGGCCCATCGCCCAAGTCTGTAYTGACTCAAYCGCC
 GCCGGCCCATCGCCCAAGTCTGTAYTGCCGGEATGACTCAAYCGC
 ...THESE GENES COULD BE PART OF A CHROMOSOME LADDER/CHAIN ABOVE...



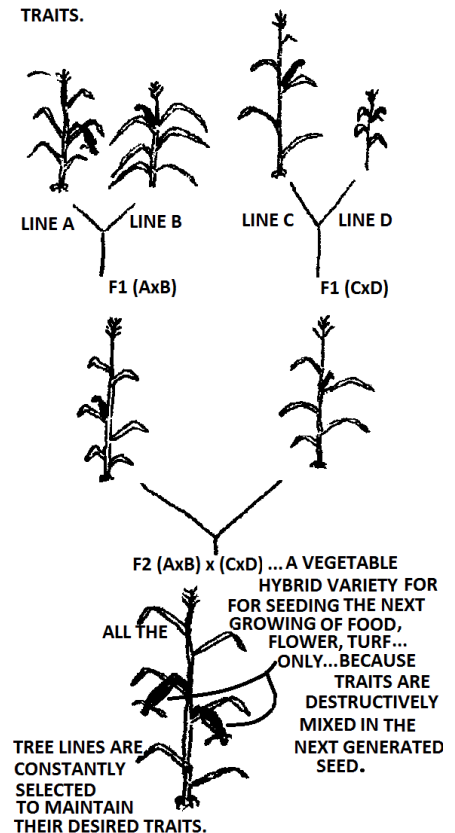
VI. Working definitions:

- A. **Chromosomes** are: Packets of heredity which make cell reproduction an orderly migration and plant reproduction a statistical process. Think of chromosomes as playing cards $n = 14$ card suits, 2 decks used to show $2n$ pairing by card values and backs. The parent cell undergoes two divisions, one replication of chromosomes with cross over bits of chromosome (cleaving card to show two deck parts on one card back) in the first division, shuffling of chromosomes and reduction of $2n$ to n for each of 4 daughter cells in the second cell division. The parent cell divides, dividing its $2n$ chromosomes, which reproduce alike chromosomes during cleaving, cells and chromosomes remain divided, go to 4 daughter sex cells with $n = 14$ chromosomes each in the second division. Face value pairs off to the nuclear number, $14 = n$, which is shuffled twice and ends up with n , but from two decks, and a number of cards reassembled as parts of two decks, **bi-deck bit cards**, same value in n . The large germ cell in the ovum is grown into by the small germ cell of the sperm where they recombine to make a seed communicating compatibility/sameness/value in pairing the $n = 14$ male to the $n = 14$ female in the ovum. Once they have communicated sameness they have to communicate small differences within the re-coiling of like pairs, the $2n = 28$ combination, with chromosome pairs coiling together to manufacture chemicals needed to sustain life of the tree cells, but not quite as either parent cell did. For difference there is sex, shuffling to switch chromosomes, and bits of chromosome to express a new genetic difference. In actuality each chromosome is a long coil molecule built from four nucleic acids, four types of DNA (a, t, g, & c). These are the molecules wound together for cell functioning, or before the next sexual reproduction. Mid-west and oriental persimmon have 90 chromosomes, $n = 15$, $6n = 90$ in each persimmon cell nucleus, and we see how the female manipulates of cell chemistry, controlling it to make a seedling be like the female parent. American hybrid chestnut $2n = 32$ can be $31/32$ & more (with bi-deck bit) American.
- B. **Genes** are: Traits written in sequences of the four simple nucleic acid molecules that form the chromosome molecule. Genes order up plant features, and host chemical processes. Another simple nucleic acid, RNA, acts as a catalyst in duplicating the chromosome by using its sequence to cleave and arrange DNA pattern.
- C. **Dominant gene** is: A gene which will express its characteristic although paired with a gene which tries to express a different form of that characteristic.
- D. **Recessive Gene** is: A gene which will express its characteristic only if paired with another gene expressing that form of characteristic. This trait remains hidden when paired/masked with a dominant gene. The dominant gene expresses its own trait.
- E. **Reproduction** is: The division of an individual to multiply itself.

1. **Asexual reproduction** attempts to multiply the plant exactly, cloning it by sprouts which slough off to grow on their own. Absorbed genes and genetic slips "breed" sports.
 2. **Sexual reproduction** attempts to multiply two plants by combining their traits. Involved is: Chromosome separation then random migration to form unique germs (spore cell formation), pollination, fertilization, undifferentiated cell division, differentiated cell division as genes express the rudimentary plant.
- F. **Propagation** is: Reproduction.
- G. **Breeding** is: The production of healthy plants by sexual reproduction.
1. Transmission of the genetic code from generation to generation without much garbling by chemical, electrical, radioactive or other physical interference.
 2. Matching changes in the genetic code to changes with the environment. Trading uniformity for vigor by mixing parentage with conditions.
- H. **Abortion** is: The death of the embryo, rudimentary plant, because genes conflict with the environment or each other as they express.
- I. **Selection** is: A term used to describe:
1. The process where fit plants propagate successfully and weak plants die; not cold hardy, able to extract/use minerals, resistant to disease, insect.
 2. The choosing of a plant for propagation.
 3. The plant chosen for propagation.
- J. **Clone** is: An individual multiplied by asexual propagation, cloning.
- K. **Variety** is: A selection which is widely propagated by cloning and gains recognition by name. Also, in-bred vegetables, grass, which look selfed.
1. A **grafted variety** is a tree propagated by transferring a growing tip from that selection to the terminal of a related seedling so that the selection replaces the seedling above the union.
 2. A **seed variety** is usually a named garden vegetable which maintains its uniform genetic information from generation to generation by isolation and sexual reproduction in the thousands within its group (a line), generated by many seeds expressing uniformity, and bred by saving seed of the best plants.
 3. A **hybrid seed variety** is an end result of **line/seed variety** breeding, the harvested generation of a grass or vegetable has known fruitfulness (growing out some seed proves its value in uniformity/quality/hardiness.) These hybrids have previously explored resistance, vigor and yield in the hybrid crop generation. Going farther in generations is hampered by poor sorts and non-uniformity. Pollen sterile lines are sought to choke lines down from many to few with just the right diversity.
- L. A **Vegetable Line** is: Known seed variety. It is being bred toward variety status, or as fixed parental group/maybe a line in the production of a seed hybrid.
- M. **Strain** is: Similar to seed variety/line, except less uniformity is expected. The example is Layeroka pollen sterile strain chestnuts with renewed characteristics of the seed parent. Layeroka, usually predominate when bred with similar chestnuts, or better yet, Layeroka strain chestnuts that are not pollen sterile. Layeroka has faults; too watery a kernel, too productive to maintain healthy trees or crops, too thin a nut hull to crush-off of punky nuts, too tender to deep winter cold, but we find improvements among seedlings that look, and act like Layeroka which is a pollen sterile European hybrid.
- N. **Race** is: Similar to seed variety except likely to have been bred by chance in the wild and in isolation. A genus contains species which do not easily cross, but a species contains races, very similar, and easier to cross.
- O. **Sport** is: Change in the genetic code or chromosome folding of a typical cell which perpetuated itself because it was caused by a genetic slip at a growing tip, which takes over like a top graft. Sports often arise in hybrids when the genetic code is affected by electrical, chemical, radiation or other physical, or RNA interference.



A LINE IS THE PRODUCT OF SELECTING TO HOLD TRAITS.



P. **Sterility** is: Blockage to breeding which separate similar breeding groups from each other. Mountain ranges, oceans and climates are physical blocks which produce races that develop chromosomal blocks. American chestnut and Chinese chestnut hybridize (somewhat) although the hybrid contains a long loop of one Chinese chromosome which will pair very imperfectly with the shorter American chromosome. This is likely to cause bad results...cross link slippage and other needs for grafting the few good selections.

1. Differing chromosome count, or break point, and improper pollen tube length or size are fertilization blocks.

2. Genes, which are poor at using existing heat units, photo intensity, day length, cell chemical concentration, cell size, maturation time, or other physical stresser, typically cause abortion in cell, seed, or seedling.

Q. **Back cross breeding** is: Breeding a hybrid, the F1, back to one of its parent species to increase desired traits, BC1. The desire to make American chestnut blight resistant breeds Chinese back to American through F1, BC1, BC2, BC3 generations of selection looking for resistant trees. Then BC3 selections are bread together hoping for selections of enhanced resistance and American form, the BC3F2 generation. BC3F2 selections are crossed for final 15/16 American BC3F3selection, the resistant American chestnut of tACF.

R. **Identical twins** are: A double embryo, each the clone of the other, caused by the splitting-in-two of the undifferentiated cells soon after fertilization. This looks to be a particular fault in chestnut, which does not kill off the weak embryos started in a seed, and often split the hull trying to mature two or more individuals, likely not identical twins guessed at by being a differing nutlet swarm.

S. **Selfing** is: Breeding to itself one plant which contains both sexes. The seedlings are similar to the parent but in their millions very few are clones due to the chromosome shuffling that proceeds spore cell formation. (Reassembly of the chromosome string upon fertilization results in differing suit, but same value, card combinations. Either card can migrate to either pole in spore cell formation.) Grasses often spontaneously double their egg chromosomes to asexually produce seed. Very few are clones due to chromosome shuffling. There seems to be another process at work in chestnut where the mother can insert her own genes for the embryo's. Thus, we have many seed twins of Layeroka though Layeroka is pollen sterile, and no other chestnut with pollen looks like Layeroka. However, often Layeroka seedlings can look the same. Google search **epigenes** -seed/seedling development.

T. **Pedigree** is: The family tree records kept while we select for accented characteristics visible in uniform lines.

U. **Line in Nut and Fruit Breeding** is: A family of close relatives whose desired traits often express, and are saved through succeeding generations/maintaining a line. Amateur breeders find few workable lines: Those with super "hero" physical traits like ornamental looks of size, health, flavor, stature, structure, hardiness, color, wax, time of leaf/bud/fruit, etc. Lines look alike, like name parent.

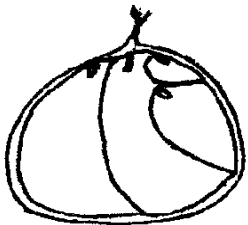
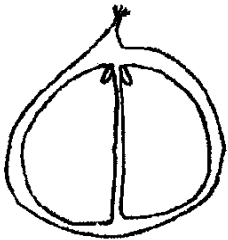
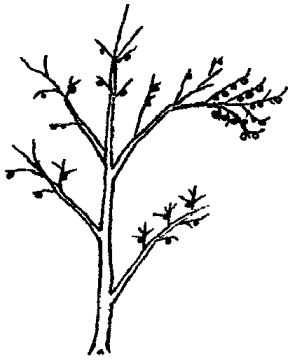
V. **Hybridize** is:

1. Breed between species by removing the isolation between them. Resulting offspring have transposed traits, increased vigor, and disorders such as albinism, sterility and tendency to sport. First generation, F1, and second generation, F2, hybrids are often propagated asexually if the cross resulted in a good tree. Hybrids have weak limb structure and poor bearing, so need work. (See the American Chestnut Foundation (tACF) articles on Backcross Breeding.)

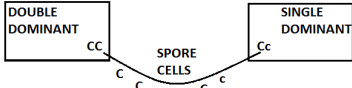
2. Vegetable hybrid seed varieties are produced by growing uniform vegetable plant lines and crossing them. The uniform lines have to be maintained to continue producing the hybrid seed which has known variety traits.

W. **Cross/Breed across a barrier/Hybridize**: Unite special individuals...a step up from random seedling selection by using selections, species, or lines.

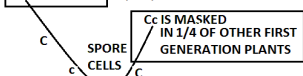
X. **Fix a dominant gene** is: Because a dominant gene expresses itself whether paired with the same dominant gene, or a recessive gene, the breeder does not know until growing the offspring of a controlled cross what the offspring will express, and thereby, the gene combination of the parents. Annually selecting desired parents will not select double dominant genes, produce seed purity, fix that gene in the population, unless it is recessive. Therefore, two parents suspected of having double dominant genes must be isolated and crossed. If neither parent was double dominant, the recessive trait will express in a fraction of the first seed generation, and the seed is discarded. If only one parent was double dominant, the recessive gene will



CROSS A DOMINANT GENE WITH RECESSIVE THAT LOOKS DOMINANT AND IT DOES NOT EXPRESS 'TIL 2ND GENERATION



FIRST GENERATION - ALL COMBINATIONS LOOK DOMINANT Cc IS MASKED CC, CC, Cc.



CC, Cc, cc EXPRESSES c, CC, Cc.

cc EXPRESSES c IN 1/16 OF A VAST 2ND GENERATION POPULATION FROM ONLY CC X Cc SEED

express in the second seed generation, and the seed is discarded. Purity of the trait in the second generation proves the double dominance in parents and offspring; the seed is saved. As long as the seed is grown in isolation from the recessive gene, double dominance is fixed/captured.

Y. **Inbreeding** is: Breeding close relatives together to fix desirable traits. Lack of vigor arises and must be controlled by selecting from a large population, or out crossing, nature's way of sustaining tree vigor.

Z. **Breeds true** is: A trait repeats in seedlings because it is a dominant gene, or paired recessive gene in that line, or it is in a seed variety where many genes and cross links control visible traits.

AA. **Breeder's records** are: Notes, tags, times, and maps kept to identify parentage and trait expression.

BB. **Non-gene inheritance** is: Polar bodies, RNA, and looping of chromosomes allows slipping of gene pairing, causing spots, and other seedling variation.

VII. Better nut trees are about us. We must select them, and breed them. Nut qualities, from flavor to ease-of-storage, attract us, but it is the trees that own these qualities. As breeders we seek to improve on varieties. We assemble trees with desired traits, seed their crop, select seedlings again displaying these traits, seed their crop, select again, steadily moving a population toward improvement.

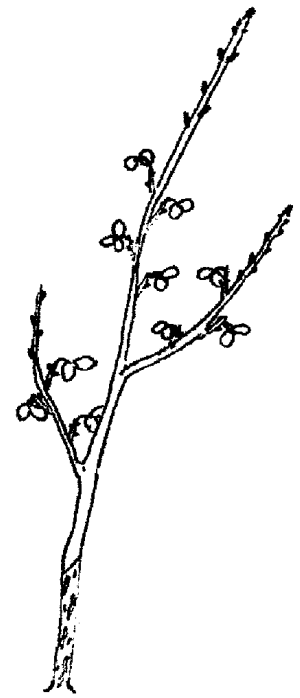
A. Probably the most important economic trait is cropping. Landscapers may not favor cropping, but are often defeated by seed production due to the turgid ornamental growing in architectural plantings. Orchardists want to see very healthy trees cropping heavily, even along the long stems of young trees. Typical nut trees are productive when mature; not productive while young (This is the opposite of Layeroka chestnut which should have learned to only bear one or two burs per terminal, but always blooms its version of side bearing, and weakens itself with each crop.) Most nut trees bear on terminals, tips of branches, which are relatively few until trees are old. We need assemble breeding trees which extend lower buds to flower like terminal buds. Not only do the old trees we are watching fail to give us side bearers, hardy trees tend not to. Side bearers tend to be the trees which grow very late into the season. Their side buds are better formed than their terminals. Without side bearing the tender trees could not seed propagate each year. We should move our tree population toward hardiness while retaining flowering, projected side buds.

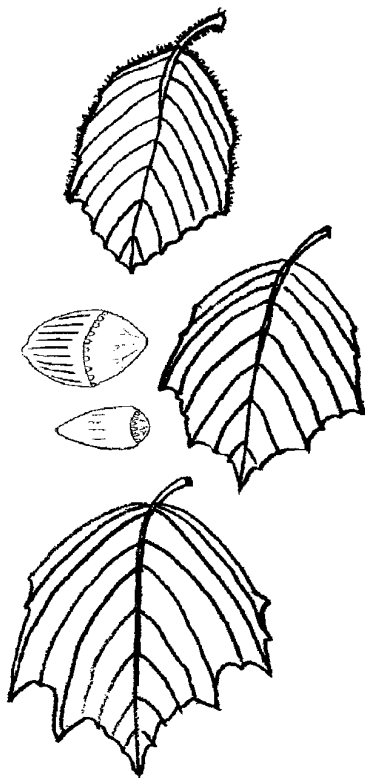
B. Next, we assemble fertility. Some of these nuts bear with very little pollination. Doug Campbell's CW3 heartnut sets all nutlets although catkins have dropped, and pollen is almost gone. The typical heartnut-butternut hybrid aborts most of its nuts. Winkler hazel and Graham hybrid filbert are unusual by bearing though isolated from cross pollination. Infertility/incompatibility-of-pollen is common in filbert, chestnut and pawpaw. It is usually overcome by having many pollinators, but watch for the unusual bountifully cropping trees, which may be self pollinators. Japanese and European hybrid chestnuts are usually more fertile than native chestnut, and Chinese. Fertile breeding lines will reward us with the largest beginning crops, but many sick trees.

C. Early leafing deserves our attention. Large, fully mature kernels are born on trees first to extend full-size, fully green leaves. In our lake moderated climate the earliest and best filling filberts, pecans, chestnuts and heartnuts can be in full green leaf a week ahead of the general population. These species can (must) take several degrees of frost, and go on to bear a crop.

D. We assemble races of nuts for their breeding potential. Northern pecans get most of our attention. The most northern race of pecans comes from the Mississippi flood plain at Bellevue, Iowa. These are maturing during 160 day warm summers. They ripen early so nuts dry

BREEDING 148 enough to take hard October frost without spoiling,



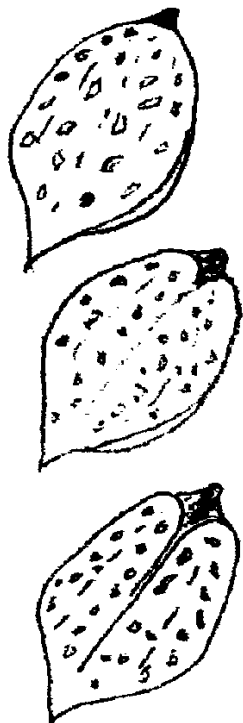


and recover energy before killing frost. A second pecan race is from the wide river flats north of New Boston, IL. These fill large nuts which can frost spoil before drying unless shaken down. and taken in. A third pecan race is from the narrow frosty valleys of the latitude of center Illinois/Indiana/Ohio. Cool night air puddles on them, trying to stunt maturity. Put these three races together, and we can sort out the best combination. Ditto, black walnuts, and hickories.

E. Some trees are super healthy, waxy, and thoroughly ornamental. Selecting these eliminates many faults, like insect attractiveness, mineral toxicity or non-absorption, mycorrhizal incompatibility, or other genetic defects which produce chlorotic, stunted or cankered trees.

F. We try to identify observable traits, which are linked with desirable, but invisible traits. That is how we hope to trace eastern filbert blight resistant hybrids. The Winkler line of hybrids is distinct enough (ornamentally red enough) to be traced through several generations of filbert and tree hazel types. Open pollination, and a large seedling stand are visually selected. Retaining selections gives us with manageable numbers of the most promising seedlings. To screen we need to know that Winkler hybrids have reddish new growth covered with plant hairs. Foliage turns orange in early October. Male catkins are reddish, small, rock hard into April. Most filberts are relatively green, hairless, ready to flower even in winter.

G. We assemble breeding partners whose traits complement. Crossing Hemming and Simpson chestnuts has shown nut improvement. Simpson is late to fill its large round nuts. In the first week of October, when most chestnuts are ripe, Simpson has some hull un-filled (sides /scare end are dimpled). Hemming is full, to over full, by late September. If it rains in early September, Hemming often splits through the sides of its hulls. Bred together they yield large dark brown round nuts, ripe in early October, filled solid without splitting.

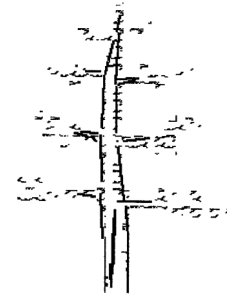


H. The combining of Hemming and Simpson nut traits shows how nut trees use genes to reorder their traits. Races with noticeably differing traits breed populations with traits between those of the parents. We select and discard to move a population toward improvement. Trying to capture a "single gene", keeping the relatively few seedling that best exhibit "it", eventually gains that gene in a genetic line.

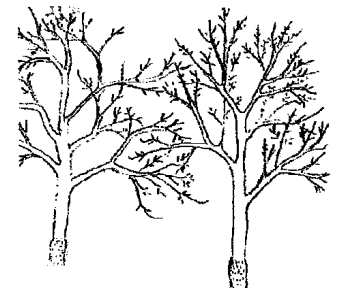
I. If xenia, the influence of the pollen parent on how the nut forms, could be seen and traced to the pollen donor, it would ease our troubles with hand pollination and isolation. Nut shape, especially in heartnut, changes greatly from year to year. Heat and moisture are the primary causes, but shape within a cluster also changes. Faust, Wright and Bates usually lack a central crease in their shell. Brock, and Etter have the central crease. In the Etter grove most Bates have flat sides, some have slight creases, and a few have deep creases. In choosing Bates seed it is tempting, perhaps wise, to save Bates with creased sides, hoping they are crossed with the better varieties which are deeply creased, indicating xenia, the pollen parent's effect on fruit. A crease from CW3, or Locket, way make a better Blunt.

J. Nut shape is very important in breeding. Heartnut reveals its kernel shape by projecting it into the shell. The central crease is one step farther in kernel projection. Kernel formation happens with shell maturation. Drought hampers kernel formation while favoring the early formation of extra heavy shells. The outline of flat, or inward sloping kernel should be seen

reflected through the shell, which does not happen when drought shuts down kernel formation, and shell formation is increased. This is observed in the kernel to shell relation in heartnut, butternut hybrid, walnut, hickory, and pecan. When rains come on strong in September and October, chestnuts suffer hull splitting. Chestnuts need August irrigation as well as adequate calcium/nitrogen likely by foliar spray. Thus, we assemble nuts, which restrict shell to a practical veneer. Doghouse shagbark/shellbark, Glover/Porter/Yoder shagbarks, Deerstand/Snaps/Oaks pecans, Burton hybrid hickory, Henke hican, Abbott bitcans, Emma K black walnut, Imshu heartnut have thin shells, but a commercial grower will also need at least August irrigation. Most nuts do in our climate.



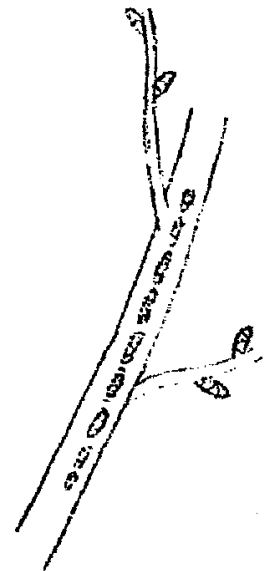
K. Where do we see most progress in nut breeding? Progress is in hardy nuts with round, easily extracted kernels. They are filberts, chestnuts and heartnuts. These are equipped with antifreeze to get swollen buds and foliage through cold swings during spring, and fall. Their shell structure is thin, simple, dish shape. Pecans fulfill these requirements, but are not properly selected for our short cool season. Hickory breeding is often confused by its intertwine of kernel and shell, but Burton has come to the rescue with consistent Porter/Yoder/Wilcox-type-nut seedlings. Persian walnut lacks antifreeze and leafhopper resistance. However, Persian's clean, thin shell and satisfying kernel will maintain interest until we put in antifreeze for hardiness.



L. In breeding filberts, chestnuts and heartnuts the required traits show themselves with regularity. Breeding Persians is sad. Leafhopper, curculio, frost, and blight resistance eludes us.

M. Cold hardiness and frost hardiness seldom appear in the same Persian tree. Persians, which run fluids up and down the tree quickly, are hardy toward deep winter cold, but swell buds early, which sets them up for frost injury and freeze cracks. These are typical Carpathians, able to perform after cold winters, but more injured at each spring swings from warm... to cold... to warm, etc., carving Persian, or chestnut bark, to be ravaged by blight.

N. The Broadview type of Persian from southern Russia is slower in responding to warm spells, and is more likely to continue dormant through spring frosts, but not highly likely. Like Carpathian it flags, sends long terminals of second growth, after wet periods during summer. Often flags do not mature, ending the season hollow with a mere shell of wood. Flags feed summer leafhoppers. The Broadview type Persians grow later into fall, retaining green leaves. In the region of the Great Lakes this fall tenderness is not big problem for any mid continent Persian walnut.



O. Persians survive. Heartnuts prosper. Both do best, if in bare soil, trafficked by toads and birds. Heartnuts are hairy, sticky, and irritating to leafhoppers. They spend the whole summer laying down thick wood in one flush of growth. Unfortunately, butternut curculio finds heartnut pith a happy home that black walnuts usually avoids. Heartnut sap is rich in sugars/antifreeze, especially Canoka. Black walnut is full of juglone. Because juglone is a cancer control like salicylic acid, it likely controls other small pathogens, like virus.

VIII. Needed breeding:

A. All nuts and fruits need hardiness, and the ability to produce quality fruit. Persian walnut is our most sought after nut, but our ability to grow it is defeated seven out of eight springs. In the eighth spring the warmth of spring continues non-stop. Growth is also non-stop, as is the crop. In the other seven springs we need the conservative growing of Persian hybrids, which does no good because Persian hybrids have worthless crops. Our ability to put Persian nuts on a hybrid frame is so slow by breeding that genetic engineering seems called for. That said, no need to grow Persians except on the shores of the Great Lakes, or engineer in a frost proofing sugar, or Persian nuts into hybrids.

B. Filbert needs: Eastern Filbert Blight resistance. Europe does not have EFB for dubious reasons. EFB has died out here due to the passing of what looks like EFB to autumn olive and back again with the EFB dying out on both; larger kernel size; more solids in the kernel to reduce shrivel; more melting kernel; more ornamental bush; more open and better socketed branching; more a tree form; lighter colored and thicker bark; deeper more truffle inoculatable roots; bud mite resistance, all of the above.

C. Amelanchier needs: More roots; berries which are more resistant to birds until fully ripe; smaller seeds.

D. Almond and apricot need: Later flowering; larger, sweeter kernel; adaptation to wet sites; thinner shells; canker and virus resistance.

E. Cornelian cherry dogwoods need: Larger, less tart cherry flavor.

F. Autumn olives need: Larger, earlier fruit; less leaning bush, a small tree; less thorny-like-plum branch. Best fruits so far are atypical yellow.

G. Northern kiwi needs: Later leafing; frost resistance; larger fruit; earlier ripening; ability to grow in full sun.

H. Pawpaw needs: More shelf life; sweeter, thinner skin; less seediness; ability to ripen under dry indoor conditions; ability to stand up to wind.

I. Stone pine needs: Ability to grow like Scots pine; thinner shelled, larger kernels and hulls like pinion pine.

J. Black walnut needs: Flat kernel; end cracking; leaves anthracnose resistant; side bud bearing; in a long lobe to embryo attachment for end cracking; a heartnut shell like Imshu's.

K. Butternut needs: Hybrids which crack on the suture like heartnut; resistance to three destructive butternut bark and root diseases; smooth shell.

L. Heartnut needs: More selections with all direction free kernel like Imshu; hardier, shorter internodes; more bearing on side buds; higher flavor like black walnut, and hickory.

M. Persian walnut needs: Hardier toward deep winter cold; in sync with fluctuating North American temperature, and spring freezes; more production from side buds; more blight resistant; more salt spray and leaf hopper resistant; more ability to grow in a cool climate like northern Japan.

N. Hickory needs: Flatter, larger kernels in thinner shells; side cracking or end cracking nuts; more insect and disease resistance on a tree with a longer, less explosive vegetative interval; more side bud bearing.

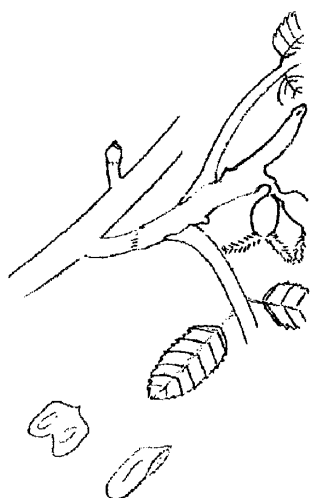
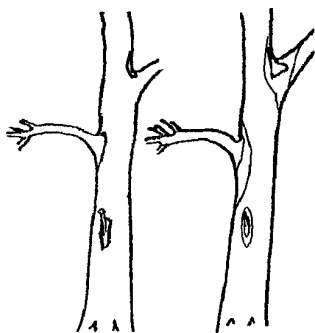
O. Pecans need: Early ripening; ability to make sugars earlier in kernels; darkening leaves at cooler spring temperatures.

P. Persimmons need: Hybrids which carry the oriental traits of flavor, post harvest coloring-up; ripening firm, large fruit without astringency, or shrinkage; earlier bloom.

Q. Chestnuts need: One pistillate bloom on each bi-sexual catkin: only four bisexual catkins at nodes above four; more blight and sun scald resistance; sweeter, larger nuts with dark hulls.

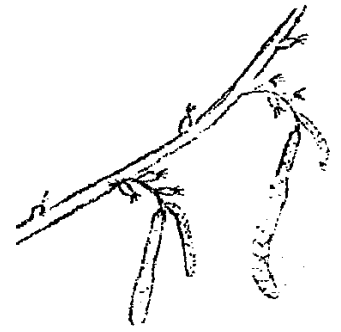
R. Elderberry needs: Sweeter larger berries with smaller seeds; less puckery.

S. In all my nut exploring in the wild for selections I only met once with the government employees gathering northern pecan "specimens", and they had no time, and no interest in gathering selections. For us, selections are payback for exploring.

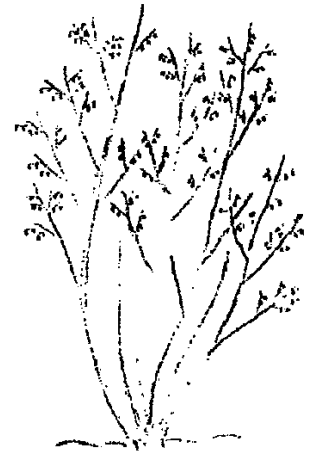


Filbert Breeding

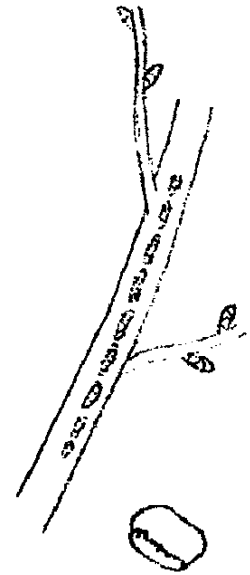
IX. Filbert traits surpass those of all other deciduous nuts in cold/cool adaptation. They developed their traits between glaciers. They pollinate during the warm spells of March and April. Unexposed flower parts endure frost and push more receptivity when warmth returns. The embryo remains a single cell until summer. Unfolding leaves, stems, unexposed flower parts, and embryos endure freezing. This says something for testing embryos by freezing to gain freeze resistance. Leaves function during the entire season despite untimely cold spells. Nuts are a yearly crop as long as mature trees are kept vigorous, and expanded catkins do not freeze. High nut quality needs our main breeding/selecting effort. Luckily, Jack U. Gellatly, George L. Slate, Cecil W. Farris, Carl Weschcke, S. H. Graham, Willard G. Bixby, J. F. Jones, J. G. Rush and others passed to us viable hybrids for crossing.



A. European filbert, *Corylus avellana*, genetically contains large, thin-shell nuts throughout the bush, which drop cleanly from open hulls before leaf drop. Relatively few nuts are in clusters, unlike the large branch-end clusters on terminals of native, *Corylus americana*. Most of the filbert crop is, and should be, in singles (a few doubles) because singles abort/drop before the true crop ripens, and are removed by mowing. The natural plant form of filbert hybrid is a bush, larger than lilac, with a single root crown (no sprouting runners please). Orchardists convert these to single stem trees. Buds are often tight and resistant to bud mites. *C. avellana* and *C. colurna* (tree hazel) have problems with Eastern Filbert Blight, harsh winters, and dry growing seasons. Flowering is often inoculated with the spores of EFB, which grows to the trunk, and in a few seasons EFB erupts from this toe hold through the bark usually from a sunken chalet centered on the dead branch-let. *C. avellana* and *C. colurna* have difficulty going dormant, and staying dormant, the product of long, moist and moderate growing in the low countries of Europe/Black Sea. We want the early maturing and dropping nuts of Barcelona, but on a tree which colors up after the first light frosts, and goes dormant through a long hard winter, and erratic February/March.



B. Native hazel, *C. americana*, is a small bush (half lilac size) which spreads itself just under the soil surface during warm, moist spells to grow a thicket. The original root crown is not easy to distinguish after several years. Thick shelled hazel nuts, from native and tree hazel, are pea size, tightly bound in hull clusters, which do not all abort/drop unless grey mold infests the cluster. Though these armored nuts fill early they drop in the bur with fall leaf drop. The open buds of native hazels, and many hazel hybrids, attract bud mites. However, tree hazel adds tighter buds and more bud mite resistant buds to breeding. The mites swell buds, often killing the terminal bud, causing the next sound bud along the stem to take over as terminal, and flower. Native hazel is in step with our season. Pollination is in April after *C. avellana* has ended. Winkler is a noted selection from northern Iowa which passes traits of hardiness, self (or super) pollination, and resistance to Eastern Filbert Blight. The bush is tiny and ornamental, turning red in October. Hybrids are larger bushes that turn orange. Much of the current work with Winkler hybrids is done by Phil Rutter in Minnesota.



C. Tree hazel, usually Turkish, *C. colurna*, imparts its traits: a large single stem tree; new bark is white and papery; older bark is corky, grey with orange fissures; leaves, glistening dark green, cut like a bat wing on lower margins; pointy red buds, slow to bear females, and bi-sex catkins, but productive after 10 years; dormant buds are open like crushed oats at terminals; pea size nuts with thick shells; high quality hazel kernels with a light color pel-





Clusters mildew during wet weather in summer and fall; few nuts release from the thick, gelatinous, spiny, tentacled clusters before leaf drop. It is a property of these large trees to quickly fill kernels even during cool, dry seasons. Hybrids, which turn out more bush form, often retain the glossy leaves and quality kernels as in Laroka, Faroka (only one with Eastern Filbert Blight [EFB] resistance), Morrisoka, and Chinoka hybrids from Gellatley. Buds are narrow and pointy like flower buds, although terminal buds remain unsealed like crushed oats, but resist bud mite, easily sending flowers. Both *C. avellana* and tree hazel can start pollination in February and sometimes complete before native starts pollination when they escape freezing. The male catkin flowers often freeze off. Despite early flowering and EFB infection, old tree hazels bear small crops by walling off infection at crotches of small branchlets. Due to the thick foliage, one has to look for the dead branchlets to notice the blight. Breeding with Winkler, hybrids such as Graham (seen healing over EFB cankers at Geneva, though poorly resistant) can increase hardy catkins. The upright growth, whitish bark, single stem, and glistening leaves make Turkish tree hazel an ornamental landscape tree. Turkish hybrids have quality nuts with large, firm, melting kernels, but so far EFB resistance has been poor, other than Faroka.

D. Resistance to EFB is not easy to gain with quality nuts. Graham and other sometime resistant New York selections were sent to a blight-test center in Illinois and failed. We await word from Rutgers. Our best current advice is to grow the most vigorous, most ornamental, and latest pollinating sorts which show native and tree hazel in their breeding. Despite native influence, the large tree of tree hazel dominates. European influence is large, round, easy-crack nuts.

E. In October of 1979 SONG planted seed of nut selections 70 km northwest of Toronto in Agriculture Canada's hardiness zone 5A. This planting on the Orangeville Reservoir property of the Credit Valley Conservation Authority supplied us with thousands of seedlings to evaluate.

F. Mid May is the time to check for large leaves among filbert seedlings. Also, check for reddening plant hairs, bat wing lower margin, and leaf thickness and glossiness. These bushes with largest leaves usually fill hard kernels quickly during the season. Large leaves in May mean large nuts in August, and full, hard kernels in September. The cup size leaves and sound kernel of Faroka tree hazel often come through. This quality of kernel brings repeat customers. Small leaves in May often mean a small watery kernel in September. A caution about surveying for leaf size; leaf size reduces as much as 50%, and takes on extra glisten when a branch starts to bear. Compare juvenile stems to juvenile stems, and bearing branches to bearing branches. There is a distinct branching pattern in bearing branches. It is easiest to familiarize with this palm flat pattern by viewing branches which hold catkins.

1. Filberts should drop nuts with other crops in October, or jays, and all other predators spend all their time at early September ripening filberts rather than going to acorns and corn. Nuts should size by late in August, ripen and begin dropping with Japanese hybrid chestnut, September 30, weeks before leaves color orange, and begin dropping in October. Kernels must be hard, not soft and watery. Barcelona comes to mind. Leaves remain dark green while nuts have pulled fluids from their brown husks. Kernels are dry and even starting to soften for the right reason, due to starch to oil conversion.

Barcelona's shell is prized. It is the thin shell, round shape of many European filberts, or their hybrids. Call me crazy, but I see tree hazel in Barcelona's back ground. Breeding has to continue away from the hard American hybrid shape of an ox heart with thick shell because customers, and cracking machines operators like round filberts. Ferrero Rocher Canada has a specification for their desired nuts, which look like the Russian selection at Rutgers.

3. In mid October the tree should be ablaze. Red or orange leaves are our indication that native hazel hardiness was passed to this tree. Yellow or bronze leaves may be acceptable, but the dark green leaves of Barcelona indicates a low hardiness of filbert flowers/lack of mid-continent hardiness. Given an extended summer, and warm moist fall, one can find bloom starting to extend Barcelona catkins, and from bud tips. Hybrids usually bloom in April. Hardy catkins are small, and have waxed brown look by October.

a. October or late March is the best time to check for bisexual catkins, and their bloom. The most willing-to-bear nut trees manifest their ability to produce flower strings. Note female flowers at the base of the catkin, and along the peduncle the male catkin, as pointed female buds size. Trees which quickly form bisexual catkins are strongly female, abnormally stout, and willing to set crops with a minimum of pollen. Many of their side buds contain female flowers. (We have temporarily changed male persimmon trees to female by heavy pruning until only stout branchlets remain for top-work grafting.) The majority of filberts have less than two peduncle female buds. If no peduncle female buds, these terminal bearing filberts usually have small crops, and not much vigor.

b. At the October survey, and anytime we see a catkin, we can count peduncle buds (PB). Barcelona, and Laroka have up to four. Ennis, Faroka, and Morrisoka often have seven. By virtue of femininity these trees bear nuts throughout their canopy, many went down with EFB (Faroka is EFB resistant, and went down due to its rootstock getting the blight.) Many were single and double nut clusters (single is best) with good leaf to nut ratio for filling. Single nuts drop blanks without sizing shells, in time for mulching. Blank nuts clusters (clusters with a minority of bank nuts) will unfortunately remain hanging, and are harvested with clusters containing filled nuts, which mature all shells through fall harvest/hulling/sorting/fanning. Terminal clusters usually have many small nuts because of poor leaf to nut ratio. However, if they only contain one or two nuts, terminal nuts are jumbo size being on vigorous shoots in full sun. When weak growing leaves hang near clusters, the leaf's reserves deplete. They go brown although filling is incomplete.

F. As we survey for selections, it pays to look for mutations. Spotting a useful mutation is painlessly insightful, while breeding is work intensive. Some variants strengthen tree structure, and take over a section due to harder, earlier ripening, thriftier growing branches. Some are neutral strength, but improved shell structure, or limb anchorage. Often weak mutations can quickly die out with dwarfism from super receptivity. Increased flowering/bearing weakens a mutant limb, doubling chances of loss due to runting.



Chestnut Breeding

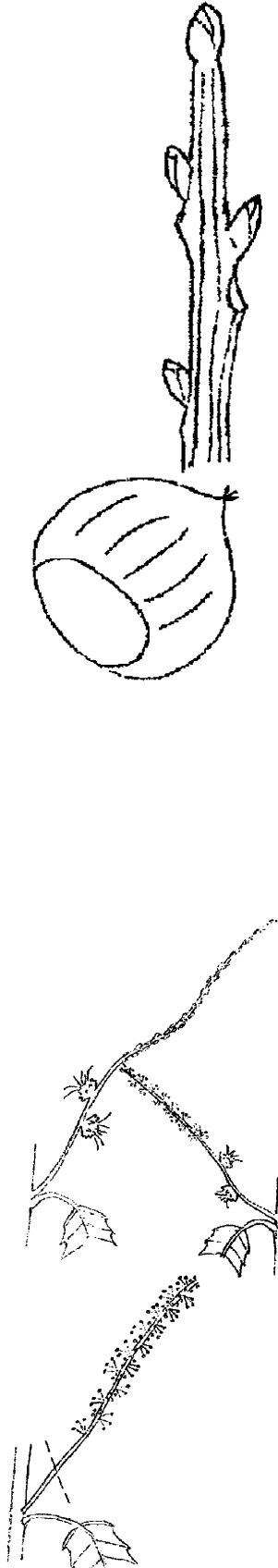
A. The exploration for hardy, and blight resistant Chinese and Japanese chestnut trees is ongoing, so a plan to start chestnut breeding is to talk with chestnut nurseries and growers. Now that the Paragon Japanese hybrid from mid Pennsylvania has been destroyed by the blight, the hybrid chestnuts which look commercial in Niagara are again highly Chinese, Japanese, and European, Layeroka sorts. Layeroka looks like Chinese/Japanese put onto a European frame tree. Layeroka's glistening leaves have Japanese margins, but Chinese/European thickness, plant hairs/mat on underside, and shape. Simpson is less ornamental, less glistening, but similarly pollen sterile, and heavy bearing. Both Layeroka and Simpson are large nuts, but too much 180 day growing season trees, hardly able to recover strength after their heavy crop to survive a harsh winter. A typical European hybrid starts cropping excellent nuts, then after three great crops dies back. Layeroka on the Lake Shore at Vineland, ONT is commercial, and hardy.

B. European chestnut, *Castanea sativa*, carries commercial traits. Nut size is as large as golf balls. Hulls and pellicles are thick to resist drying and mold. Hulls are dark brown, and thick enough to crack under finger pressure for easy removal if let dry to flexible kernels. Leaves, shoots and buds are the fattest, double the thickness of other chestnuts. Leaves and new growth carry leafhopper resistance. Like white oak, Europeans will grow on clayey, more sweet, more wet soils, and Japanese breeding can add resistance to phytophthora root rot. Phytophthora root rot is said to kill chestnuts on such heavy soils. Single embryo nuts with single kernels, are maintained. Folding of the pellicle into kernel has been eliminated by breeding with Chinese. Bark freezing and bark blight are easy occur in these European hybrids, not so much in the more American/Chinese Layeroka. Test winters below -22° F/-30°C result in frozen terminals, southwest injured bark. Layeroka (and its many twinish seedlings) are often pollen sterile, adding to the case for it being European. Immature male calkins drop unopened as female flowers become receptive at the start of summer. Catkins become bisexuals counting above the fifth leaf node catkin. All catkins which push out on second growth are bisexuals, but these nuts do not mature.

C. Jack U. Gellatly of Westbank, B.C. gave us his many 'oka hybrids. William J. Simpson of Erie, PA gave us the Simpson strain. The Paragon strain from Pennsylvania (brought back from Niles, MI c. 1978) fills nuts too late in Niagara. Full European trees die out in Niagara. Leamington, ONT has a few.

D. Though early crops of Layeroka and Simpson are inspiring, further breeding is necessary to gain hardier trees. For now, fully Chinese sorts are the better selections to graft. They are less productive, but almost as large a nut, and some are almost as hardy as native chestnut. However, chestnuts are not long lived as grafts. Planting seedlings, and moving the good seedlings into orchards is a better solution, until a good root stock is found. Nourishing nuts to proper size is a fertilizer/irrigation/timing problem. Vigor in the tree must push terminal growth to five leaves past the last nut cluster with liberal amounts of fertilizer and irrigation, or nuts are small. Chinese trees must fully form tip buds in September to be hardy.

BREEDING 155



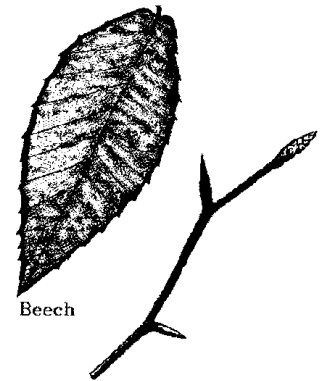
E. Viable chestnut pollen does not travel far. It loses in two hours the ability to germinate with strength unless harvested at maturity and rapidly dried, or if ripening flowers are vased as stem bouquets in floral-stay-fresh.

F. Native chestnut, *C. dentata*, is very much like European, *C. sativa*. In fact the report of visitors to northern England and Scotland is that their native chestnut is identical to ours. The bulk of its leaf, bud, stem, and nut crop are all reduced to concentrate on taking over rocky, dry sites in the forest. Our natives are hardy to -25°F/-30°C. Below that, tip buds remain hardy, but trunk bark injures just above the snow line and in low crotches on open grown trees. This injury is small and easily healed on seedling trees, unless, as often happens, blight takes hold. Native chestnuts are teardrop shape, and dime to quarter coin size, mostly nickel. Hybrids with Chinese often ripen early, size large, but tend to form the double embryos and kernels. Very light pellicles make these double kernels somewhat acceptable, not at all fibrous like some Japanese and European.

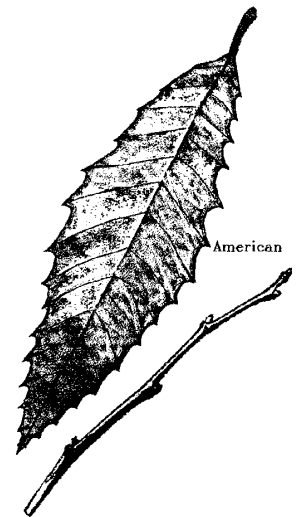
G. The Douglass strain of native cross Chinese (Douglass Manchurians) looks native except for plant hairs on buds, shoots and leaves. Blight resistance is far from perfect, but much greater than in most other hybrids which look native. Except for limbyness, and too thick a leaf density/pollen density, Douglass has grown at an equivalent rate to native seed except about the sixth season blight takes many, and all the native. Douglass is 90% culled by to bark freeze, tip injury, leafhopper injury, and blight. Their nuts seldom approach commercial size. In a conservation planting Douglass brings back the American chestnut, if the number tried was great enough.

H. Japanese chestnut, *C. crenata*, is similar to European in large nut size, marginal hardiness of hybrids, and tolerance of white oak soils. New growth is willowy. Branchlets are slender and reddish. Trunks are maroon. Buds are reddish, spherical, small beads too small to interest the gall wasp. New green shoots extend into summer, some never setting tip bud. The bark colors brown to maroon, as it darkens with age. Some Japanese races carry resistance to phytophthora root rot. Nuts are single embryo, but the thick pellicle is often stuck tight to the kernel. Nut size on a Japanese tree can vary from jumbo to small with very sweet nuts in the 1 inch range. Unlike Europeans which bear large nuts on young seedlings, Japanese rarely bears large nuts until its trees are 8 inch diameter, 30 feet tall. Nut hulls shine yellow-orange to maroon-brown with fine dark lines 1 mm. wide and 5 mm. apart drawn from scar to point. Scars are large, covering a third of the nut, like native, but smooth without the raised sunburst pattern. Leaves are long and narrow with close hooked cusps for edges. High leaf gloss links with early maturity of a tree and crop, and is often passed to hybrids. High gloss seedlings usually bear nuts early.

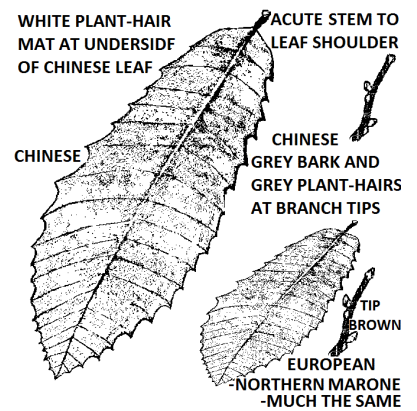
I. Chinese chestnut, *C. mollissima*, is typically a long season tree that expects droughty summers and falls. Its round nut is inch/2.5 cm size, with selections of commercial size. The scar is small and rectangular with a sun burst. Their thin, tan pellicles peel easily, and pass on to Chinese hybrids. Hemming is a short season strain promoted on the Eastern Shore of Maryland. It has marginal hardiness in Niagara, and September rains often cause its hulls to split. Hemming, Orrin, and Eaton set terminal bud in early August, six weeks earlier than typical Chinese. Moat Chinese terminals and bark suffer injury at -20°F/-30°C in mid winter.



Beech

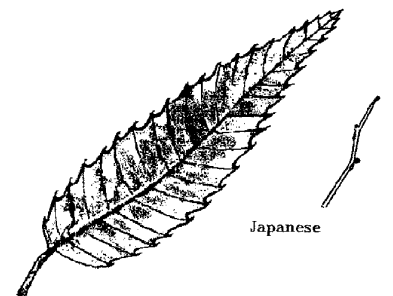


American



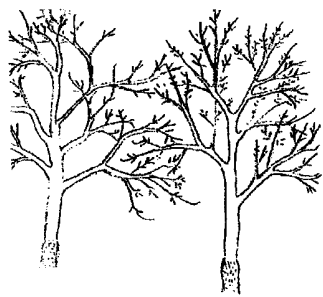
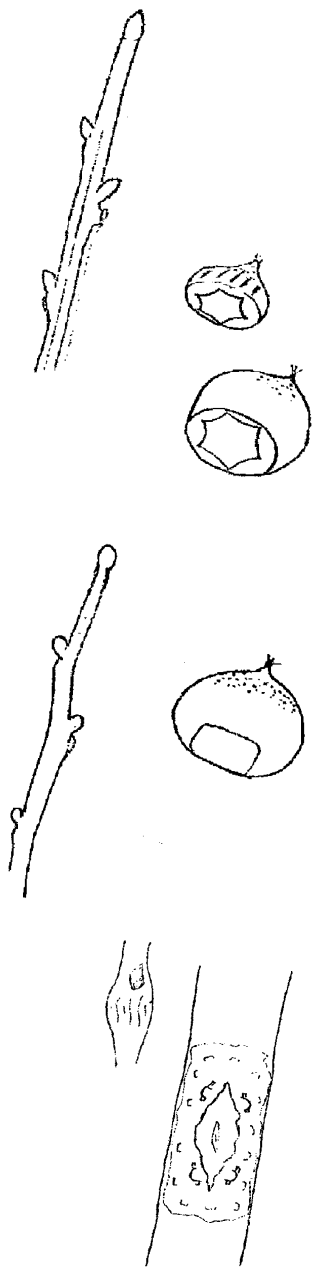
CHINESE

EUROPEAN -NORTHERN MARONE -MUCH THE SAME



Japanese

HENRY CHINQUOPIN HAS 1/3 SMALLER LEAF & PARRALEL SIDES CUT DOWN WIDTH



J. **Breeding of chestnut has to be done:** Make Layeroka sorts into dark/thick hulled, hard nuts, quicker to push bisexual catkins with some viable pollen, on a tree which is hardier and more blight resisting. Cross Simpson. Simpson has been crossed with Hemming to produce a large dark nut, very hard, and not hull splitting with fall rains. The teardrop shape of Layeroka, and perfectly round shape of Simpson, are distinctive, and should be saved. These trees have to be made hardier toward blight and weather. Cross Douglass 3/4 American back to select hybrids.

K. European chestnuts have a stout vigor. European orchardists have selected for stout, conservative growth as a quick way to large crops, large nuts, and large orchard trees, and separate chestnuts as coppicing trees for timber. European chestnut was made a non-hardy tree in our climate, and has too large buds to evade deep cold injury, and gall wasp. As we continue to plant, and select seedlings to grow out, we have to choose among growth forms that are slimmed down to allow rapid temperature change. A chestnut has to be growing more willowy, and still produce commercial crops, like Japanese. We reach this conclusion in several ways. Good bearing begins when the trunk diameter above the root crown approaches 6 inch (glossy leaves mean bearing at any diameter.) Height has much less influence on hardiness, except that turning energy into height eats the reserves needed for flowering and fruiting. Thick branchlets and buds store reserves, but do not move it quickly enough. This makes for a lot of excellent European youths that begin to yield, are injured by harsh weather, no longer support their growth, and break our hearts with senility and death. The stoutness of Prok persimmon may mark the limit for large fame and bud. Production of the plant hormone ethylene is main cause for slowed growth, and early ripening. Pecan trees which are selected for large branchlets are likely to have large nuts, but thin, poor fill in Niagara. The more moderate pecans usually put more kernel into their nuts. The chestnuts, Layeroka and Simpson, are more stout than Prok. They decline to the ground, as do most of their seedlings, after a few years of bearing super nuts, then renew themselves from root sprouts like blighted natives. Not enough sugars might be fed back to their roots. Is this some chemical clogging their sap flow tubes? Blight bodies travel in these tubes, but cannot cause blight within them without prior injury. The work around may be to breed with Japanese, the willowy chestnut, which does well in our cool climate, producing sweeter nuts. Salicylic acid/aspirin, and in the nutraceutical seasoning curcumin/turmeric, is in birch and willow, and I hope it is in Japanese chestnut to cleanse sap of clumping bodies.

Heartnut Breeding

XI. Some of the best heartnut selections in Niagara have come as seed from the Etter variety grown in southern Pennsylvania (Mercersburg). Looking at the row of Etter trees, it is apparent why. Etter ripens and goes dormant ahead of its neighboring heartnuts, and nut trees, except for the Weschcke shagbark hickory from northern Iowa. Etter is several weeks ahead of the Brock, Rhodes, and Faust heartnuts. Etter, Brock, and Faust have thin shells with well rounded cavities, Rhodes is a flat nut, and is latest ripening, not for Ontario, or NY. However, even Rhodes heartnut is much like butternut, containing enough antifreeze in its sap to overcome deep winter cold, and spring and fall frosts in Niagara, but not Montreal where only heartnut hybrids are hardy.

A. Etter seed has provided Doug Campbell with seedling selections like CW3, by which to judge marketable heartnuts. Whether Etter x Brock, Etter x Canoka, or Etter x Bates, we can speculate, but need to read the code. Their shells are thin and flat enough to dump kernel. Heartnut kernels resist going rancid for a year even if the shell seal breaks on drying. Their kernels taper down into shell cavities so that they dump out kernel. Tapping or squeezing at the suture splits apart their shell halves. The kernels lay on the shell halves. Other heartnuts in this class are Imshu, Locket, Campbell West, and Stealth.

B. Both heartnuts and butternuts were planted at Orangeville, ONT. The butternuts are hardier and taller, less limby. The heartnuts are stouter, bore earlier, aborted fewer nuts, but are unlikely to be hardy.

C. Although heartnut has stout vigor, it is overly male. Most of the buds are catkins. It is not unusual to find that only the terminal bud is a flower and leaf bud, the flower stalk arising on a short stem of off the new growth like most nuts. CW3 has born nuts on side buds, but not like filbert, or pecan does. The CW3 terminal bud has to be injured to notice forcing of the side buds and bearing. Usually, side buds on heartnut do not break dormancy, or are stunted by the vigorous growth of the terminal. Without side bud bearing, we wait years until tip growth slows to improve production on heartnut trees. You should notice that CW3 side buds sit out on a projection of stem.

D. **Butternut breeding** is slow breeding, but will come along with heartnut breeding due to their easy crossing, and the many good hybrids produced like Craxeasy "so-called" butternut. Heartnut gives more resistance toward the three diseases knocking down butternut. Nut production, nut structure and hulling are improved over butternut. Heartnut's spreading tree form is not orchard friendly, thus improved by the butternut's tall frame. The Mitchell Hybrid is an example of improved hardiness, earliness in heartnut, and shell in butternut. The Filzinger hybrid makes a valentine out of black walnut. Flavor and shell rival CW3, and the puffed up, but dry puff hull like Jubjube/black walnut, aid hull removal, and may help explain why Filzinger does not get husk maggot, or butternut curculio.

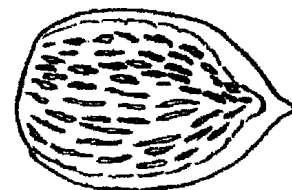
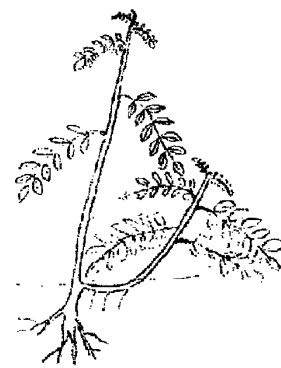
E. Like filbert, once a good heartnut is discovered, it **can** be air layered, and propagated by stooling. Grafting pushes heartnut to bear, but grow flat. Rooting heartnut selections should reduce early bearing while the tree grows upright.

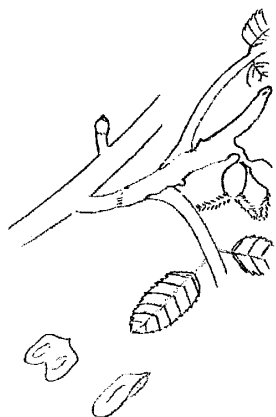
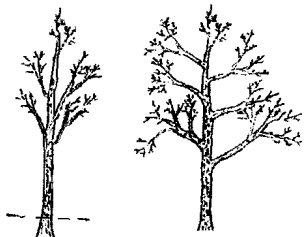
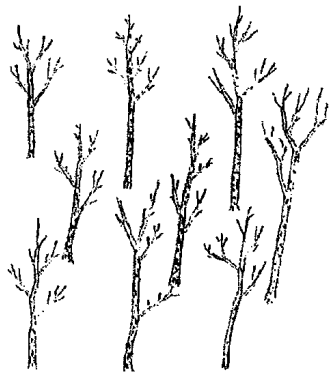
F. The sharp point of a heartnut should be eliminated as done by crossing Covell Manchurian walnut with heartnut to produce hybrids like selection Blunt. Canoka is the highest in sap sugar and must be kept for frost resistance. However, Canoka and its seedlings have kept both sugar sap, and a most-flesh-wounding point.

Black Walnut Breeding

XII. Native black walnuts grow to become large, productive, "estate" trees. These natives show very good adaptation which usually includes a very hard nut shell. Our orchard plantings never grow timber trees as easily as timber plantings due to too little crowding to form timber. Use care by suppressing grass competition, and pruning infections spread among receptive bleeding wounds. Some work is done to improve nut crops from black walnut. Although their kernels are valuable, we lack the set-up for commercial extracting that are as small-scale-commercial as is pecan kernel extraction. Where black walnuts are processed commercially, the very hard shelled, round nuts, and are valued over long nut varieties because roller spacing lets the long nuts escape cracking, or crush kernels on end. Long, flat walnuts, Emma K sorts, are hand cracked to orient them to end cracking.

A. Archie Sparks of Beaver, Iowa is propagating trees which bear heavily off side buds. Many of his selections are in the line Elmer Myers. Elmer Myers has a thin outer shell that merely cracks outer shell in roller crackers, so the Sparks selections overcome this defect by making the whole shell fragile. Many black walnuts have limb sockets too poor to easily trim, and change into orchard trees. Elmer Myers is an exception by maintaining one major center main stem as the leader and suppressed side branches. It is a timber tree and good nut producer. Forest trees socket lower limbs for sloughing, rather than reinforcing their trunk sockets with wood arches, top and bottom, to grow limbs in the open, which load. These load with nuts in orchards. Emma K, Sauber, Sparrow, Sparks 127/129/147, Clermont, Quikrop, are candidates for breeding dual purpose black walnuts. These are chosen for tree form, nut quality, foliage health and lateral bearing.





B. During hot, heavy dew, heavy fescue seasons the fungal diseases, anthracnose, defoliates black walnuts, ruining crops, especially at sites thatched with red fescue grass. Hybridized black walnut with Persian usually rids the anthracnose and walnut blight, but has not produced a usable nut. Ken Dooley of Marion, Indiana, has bred some likeable hybrids, but lack production, black walnut flavor, or far north hardiness.

C. Purdue University in Indiana is making progress with clonal black walnut varieties, and several are patented. These are upright, fast growing trees for open growing where both logs and nuts are produced (dual purpose). These help our dream of returns from 20 year old trees while waiting for timber to 35-50 years.

D. Weakly supported side branching is a major problem in black walnut and pecan nut orchards. Approximately 80 percent of seedlings from the wild have weak crotches. This is genetic. Trees in the forest are sky-climbers, whose side branches are only temporarily in the sun, and are quickly sloughed as the top grows. These are not orchard trees. To buttress side branches would grow limbs into shade, which would inhibit clean sloughing. Many nut producing selections have to be discarded because of improperly connecting side limbs to the trunk with too small of wood arches above and below branch union. Elmer Myers is a dual purpose tree which is suited to open growing. Its central leader extends to the top. Side limbs spread horizontal, and are well socketed. This is the type of tree to be kept when after timber and nuts.

E. Until black walnut extracts like heartnut, it will continue as nut with troubled cracking, a basement cracking nut banned from the main household. Without clean, easy cracking a target price of \$1 per lb./ \$2.50 per kg. for in-shell nuts is hard to get. Black walnut has been crossed with heartnut, as per Filzinger. There is interesting breeding to be done using Muhleman black single lobe (actually, the embryo region is enlarged and there are no lobes.) The feature we like is dish shell, dumping of heartnuts. There is great difficulty in retaining black walnut flavor in hybrids. Unless extraction is eased in pure black walnut there may never be a hybrid with black walnut flavor. We have many hybrids, but never the scent of black walnut.

F. The line, Emma K, looks most interesting due to a shell structure with thin walls, a long slit opening to unite kernel with embryo (this slit weakens the shell in end cracking), and a long length to orient the nut for end cracking. Nut hobbyists will find this structure easy to crack while looking for machines that improve cracking, and seedlings that improve this nut structure.

Persian Walnut Breeding

XIII. After growing out generations of Persian walnuts in southern Ontario, one might expect some Persians to be nearly native trees, but none are close yet. We have a market for these thin shelled, bright nuts, and the trees which produce them, but no Persian variety is promoted for commercial production, except at the Lake's edge. The same is true in Texas where Loy Shreve brought many varieties back from Europe for breeding: No success in TX.

A. Establishing a grove of Persians is difficult. Even on apple sites Persians suffer from spring frost, leafhoppers, -22°F/-30°C winters, and fluctuating temperatures which race above and below freezing to swell, and kill buds, freeze bark, and split trunks. Persians remain a

maritime-southern nut. Even mid continent European Persians suffer here. If these become large trees, they lose fewer nuts due to late frost, walnut blight, curculio, and husk maggots. Few growers can afford young partial crops, or the long wait to grow large trees.

B. Growers look for late leafing Persians to carry dormancy through the warm periods in March/April/May. Comparing Persians with northern pecan shows this is too simple a solution. Many Iowa and northern Illinois pecans are cold hardy to $-26^{\circ}\text{F}/-32^{\circ}\text{C}$, which kills tips off Persians. These **pecans lose buds showing leaves to hard frost $27^{\circ}\text{F}/-2^{\circ}\text{C}$ while Persians lose all swelling buds**. Texas is sticking to raising pecans.

C. A super dormant type Persian could allow temperature swings from above freezing to near record lows well into March. However, it remains likely that bud movement signals the end of any freeze resistance. Shreve S3, Burtner, and other late leafing Persians have shown less injury due to less May bud swell.

D. We need Persians which allow a slight freezing of leaves while the center of the bud is protected. CW3 heartnut is the analogy. Canoka's sugar sap is the solution. However, breeding will need the aid of genetic engineering to cut sugar sap out of heartnut and move it to Persians.

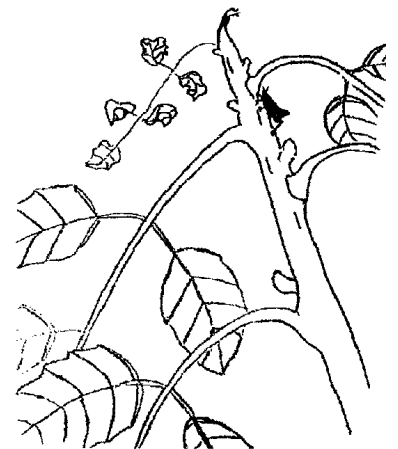
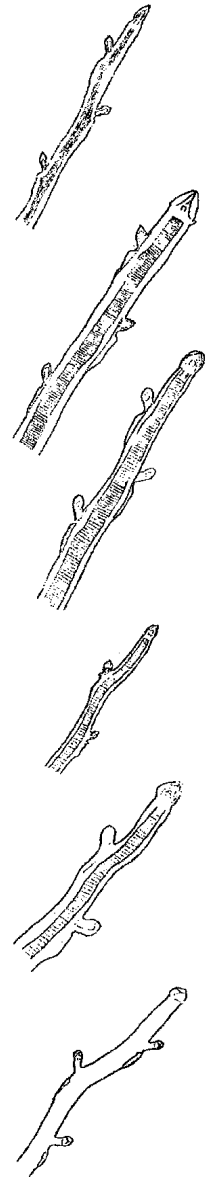
E. Stateside, Persians (and chestnuts) are said to suffer from Interstate 80 disease. It is a rare Persian which crops north of I-80. The same could be said about pecan. Snaps, Deerstand, Oaks, Jumbo, and Cornfield are native pecans from 50 mi/90 km north of I-80 (Bellevue, Ia.) Other pecans in this mode are Diken and PC Long. They are cold hardy to $-40^{\circ}\text{F}/-40^{\circ}\text{C}$ in winter.

F. Heartnut is also affected by a I-80 distribution. Heartnut leafs early in south Illinois, Indiana, and Ohio. Warm spells, then sharp freezing, have bled to death heartnut trees which were in full leaf in May.

G. Does heartnut have reservoirs for dumping freezing water: (pith, unfolding leaves, wood)? Is the sap high in sugary antifreeze, and able to supercool without freezing? Does heartnut wood grow volume and flexibility to regulate fluids to slow freezing? Heartnut leafing is slightly ahead of butternut, way ahead of Persian bud swelling, well ahead of black walnut, pecan and hickory leafing. Despite early leafing, heartnut produces crops regularly though the outer leaves are often burnt by freezing. The core of the heartnut bud remains protected. At this same freeze the Persian bud is frozen through the core.

H. Heartnut and pecan grow their tender terminals during the heavy attack of leafhoppers in July. Sticky, hairy heartnut shoots repel. Pecan and hickory toughen leaves earlier than Persians, and insect activity. Lacking leafhopper defense, Persians may have to cease growth in early July to display leathery leaves like hickory.

I. Some early leafing Persians, Papple for example, are hardy to deep winter cold, though nowhere as frost resistant as heartnut. Bauer 2 is similar, and has a pointed bud which opens more like heartnut to size outer



leaves before moving the inner bud. Both suffer from walnut blight, leafhoppers and husk maggot. Bayles, Young's B-2, Korn and Nebraska have unusual hardiness. During test winters nearly 20% of their seedlings are winter hardy compared to about 5% hardy seedlings from less hardy selections.

J. Today's orchards depends on trees which bear heavily while young. To be commercial almost all fruit and nut trees have to be side bearing for early production, rather than terminal bearing which necessitates large, mature trees for production. Side bearers have side buds on spike projections, like Bauer 2, and most pecans. Projected side buds can be seen on 3 and 4 year old seedlings which carry this trait.

K. To gain improvement and produce hardy Persians we have to grow out more, and better seed. We must select critically among the seedlings in future generations. The New York Nut Growers Association started a Persian Walnut Project with seed supplied by the Grimo Nut Nursery in fall 2005. Selections were Papple, Lake, Harrison, Iowa S.U. 73H24, and Combe. These are most blight resistant, and winter hardy, and supplied by Ernie Grimo.

Pecan Breeding

XIV. Pecan is native to North America. The most northern races grow on the Mississippi at Bellevue, Iowa. See the pecan search maps at Front Pages.

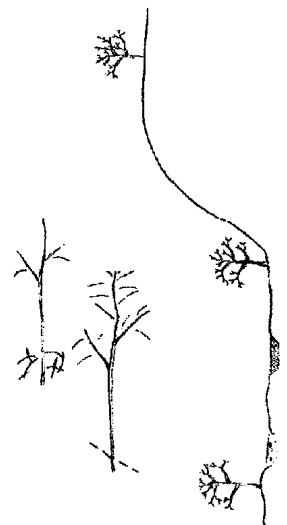
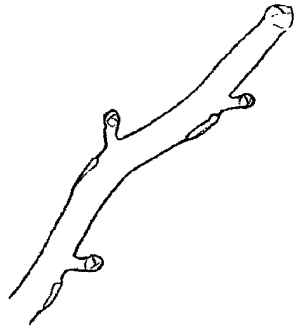
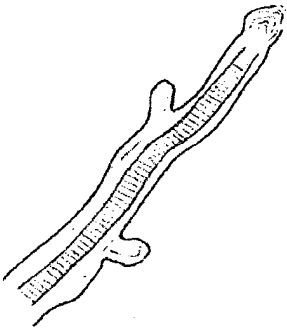
A. Some years many northern pecans ripen in Niagara. Other years only the quick ripening northern pecans; Snaps, Deerstand, Oaks, Diken and Cornfield ripen on the tree. Growing out their seed should produce other selections.

B. We have gathered many pecans which mature early. Early ripening evolved for three main reasons. The Bellevue race, above, has a short growing season. Where native, some of these nuts have enough fill in mid August (Snaps, Deerstand, and Abbott bitcan) for squirrels to begin harvest. Evers is a southern pecan incorporating early fill in Texas breeding. Evers resulting progeny, Pawnee, was too tender in Niagara to discover what it does here.

C. A second group; Gibson, Fritz, Fritz Flat, and Anderson Flat are large nuts from the wide Mississippi flats just north of New Boston, IL. It seems likely that these pecan trees will perform much better as they grow tall with age. Shaking down, gathering, and inside curing will give these nuts the frost protection needed for kernels to cure without frost injury. Their trees start the season too slowly; leaves size slowly, and never reach healthy green as soon as walnuts, or the several early Bellevue pecans. Their leaves color by November, usually ahead of nut drop.

D. A third group is from droughty regions and steep valleys where nuts need to ripen early, and trees need to harden before lack of water forces premature dormancy. The original group planted in Niagara was too near the Ohio Valley. Colby did the best. Now we have S-24 pecan, and Lucas pecan from mid-Illinois to mid-Ohio. These ripen with the larger Bellevue sorts.

E. Our pecan breeding strategy is to cross these three groups (quick northern, large cool night, and quick drought) and sort seedlings to match



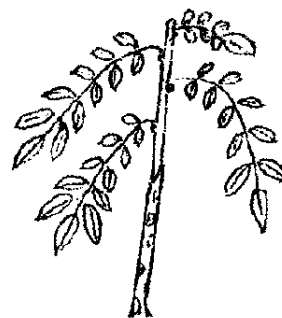
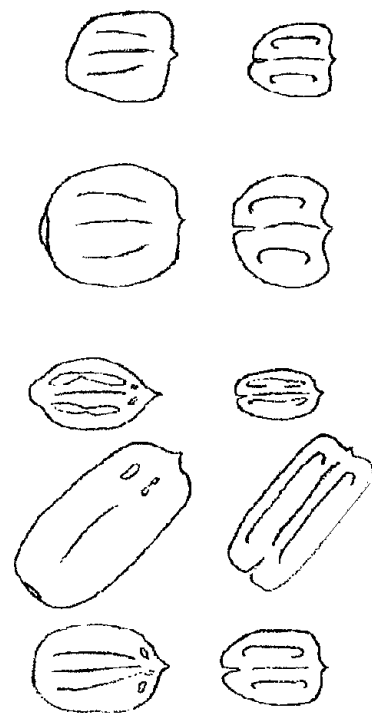
the traits of quick northern selections from Bellevue, IL. Earliness in leafing is exhibited by Snaps, Deerstand, Oaks, Cornfield, and Gibson. These pecans show leaves of healthy black walnut green to match the timing of local black walnuts. Nut sizing is expected in August, and filling in mid/late September. Shuck splitting and nut drop should be in late September, before coloring in mid October. Petioles should drop from the tip buds during the first hard frost of October with no bleeding.

Hickory Breeding

XV. Hickory breeding is slow, as is the invention of hickory nut crackers. Burton hybrid has many seedlings equaling the selections Yoder 1, Wilcox, Neilson, Cedar Rapids, Porter. Many large select shellbarks, hicans, and fine hickory selections need blending. Shagbarks: Yoder 1, Wilcox, Neilson, Cedar Rapids, Porter, Glover, etc.; Shellbarks: Fayette, Keystone, Henry, Scholl, etc.; Hybrid hickories: Burton, Doghouse, CES-24, etc. Most have produced seedlings with shells that match their female parent. Burton seedlings look/crack most like Yoder 1, Porter, Neilson, and Wilcox, so expect this match to keep showing up. Ernie Grimo has seedlings of these that size their nuts a third larger. Most hickory growers believe that the shell of hickory needs the most improvement, but clinging kernel, and the time it takes to grow out hickory, keeps most growers from trying. Hickory's complex shell, early arrest of growth in spring, poor leafhopper resistance in second growth, and September dormancy point growers to pecan for improvement. Hicans with shellbark flavor are Henke, Burlington, Hy-6, Gerardi, Rockville. Hicans with pecan flavor are Abbott sorts. There is a mistake in planting poor hickory nuts when good hickory nuts come easily from good seed. Burton should be favored as the seed with the thinnest shell, and proven seedlings to make our life easier. Produce these seedlings for estate hickories.

A. There will always be a market for round hickories like Yoder. Since W.W. II a nut industry was built on northern pecans. It remained small until cracking machines shelled full half kernels to show what a delight these smaller northern types could be. These machines will crack hicans, but not round hickory. Thus, we are breeding toward long, end cracking hickories. Hicans from these northern groves are top priced like the largest pecans. Where native, hicans fill and drop ahead of the pecans. Native chestnuts get accused of being hybrid when they resist the blight. Pecans are accused of containing hickory when they ripen early.

B. Relatively few hicans exist in the wild. At the native pecan grove near Bellevue, IA, one hican, HY-6, was found, along with over 100 pecans and nearly 30 shellbarks. We don't have many good hicans to point to because there were few to chose from. Only Henke, Burton, Burlington, Gerardi, Rockville, and Des Moines have the reputation of loading up with good nuts. Of these only Henke hican, Burton hybrid, and H-6 fill easily in Niagara. Our energies would be well spent in growing out hicans. The hican cracking machines that crack out half kernels are those in use for pe-



Native Persimmon Breeding

XVI. Persimmon is a minimum spray native fruit. Many nut growers have this tree which grows broad, fruits early like Chinese chestnut, and loads so heavily with fruit that shaking and harvesting twice a week for wine making seems the only way to cope with crop. Selections are grafted females known for quality. Seedlings are usually completely male or female. James V. Claypool of St. Elmo, Illinois was the leading breeder of native persimmons, turning out thousand foot rows of known crosses each year. Tree spacing in row has gone from 10 ft. to 5 ft. to 2.5 ft. as seed production grew. The Claypool's strategy was to hand pollinate taking pollen from the occasional male flowers on female Early Golden strain selections. Early Golden is a proven parent, known to produce selections even when open pollinated. Its fruit is the highest quality, and has no astringency upon ripening, **but to check ripeness you always have to break skin, and sniff a pleasant, fruity smell before tasting.** Using pollen from these top line females, and setting seed on other named selections like Yates, Claypool moved selections ahead at a high success rate. Other Claypool breeding partners are: Morris Burton for red pulp which holds quality through storage and cooking, Mitchellena and Jewel for overall quality, and Wabash for early ripening. Wabash was extra early it imparted a disgusting taste, and has no selections.

A. My breeding is by open pollinating using only the earliest male pollen trees that have best health. The earliest ripening Niagara persimmons female selections are: Dickie, NC-10 (from Doug Campbell), Yates, Campbell (from Indiana), Geneva Long, Geneva Red (one of the better Morris Burton seedlings), Richards (too soft), Pieper, Szukis bi-sexual, and the excellent, but will-it-ever-ripen Hess. Szukis is has many male branches shedding the earliest pollen, and few female branches early ripening top quality, healthy fruit to speed our persimmon breeding. Geneva Red is as unusual as Morris Burton, and may make dry wine. We need a commercial use for large crops.

B. Early ripening persimmons are those which flower early, and get a head start toward ripening. Only one in a hundred males is early enough to cover the female bloom of our earliest selections. It takes bees a few days to start collecting nectar so select males which start shedding a week ahead of any female bloom. Szukis does this.

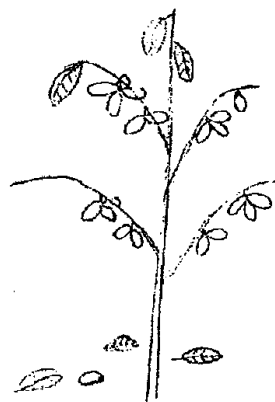
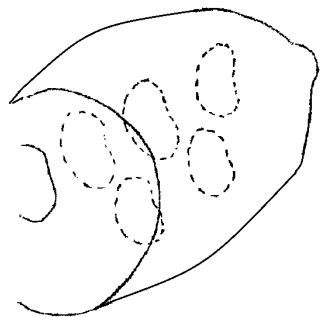
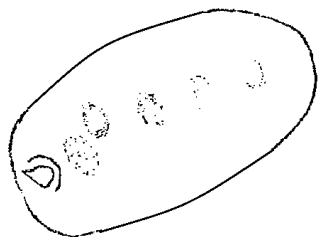
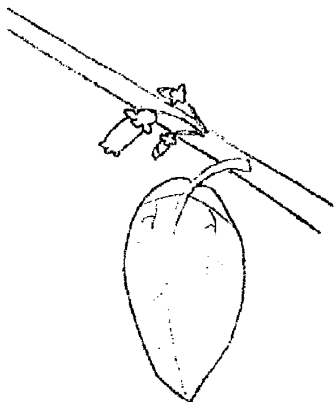
C. To gather pollen, dry the flower in a pre-warmed oven (door open, as it cools) for an hour to free the pollen. It will shed with a gentle tap on a glass plate, leaving a small smudge. This extracted pollen (you cannot see the grains) is moved onto female pistils, using a sharpened pencil eraser, or bulb of a thermometer, usually collected in quantity in a vial.

D. Breeding makes it necessary to remove many unworthy trees. Persimmon roots suckers like plum's. Removing persimmons without starting all its suckers is tricky, but possible. About mid May, as you are discarding all the male trees which bloom too late, girdle the unworthy tree at flowering, chipping the bark downward with a hatchet. Put a teaspoon of Tordon RTU or 2-4-D in wounds chopped above the girdle. Later put 2-4D in the wounded root crown where still showing sprouts, but very little, and no Roundup. Do **not** use Roundup where there are root grafts to other persimmons, or they will suffer, and may die. In two years you can break over killed persimmon to discard it.

Pawpaw Breeding

XVII. The pawpaw tree has the leaf, and general appearance of a flowering magnolia, but especially young American magnolia. With its bitter bark and leaves it will grow in a goat pen with little injury. The injured green parts of a pawpaw repel with a harsh green pepper odor, and taste. The typical Niagara native has little quality except for some St. Davids fruit. It is easy to switch to the quality fruit from the Michigan/Indiana border: Banana quality, pear-like skin on the outside, creamy pulp, and button-brown seeds are on the inside. Seeds are full of white needles like the egg mass of praying mantis. The way these cells freeze injure may cause the great hardiness in pawpaw.

A. Edible pawpaw fruits are difficult to obtain. The typical offering tastes like banana dipped in cleaning fluid. The problem is the way pawpaw changes its chemical repellent to fruity attractant. Many pawpaws fruit don't manage to complete their ripening. The chemical smell of green skin changes to pleasant pawpaw fruit aroma on the tree which attracts raccoons, possums, bats, snails, and fruit flies. The skin of ripen fruit dimples BREEDING 163



to a light finger pressure. No ripening off the tree means no shelf life, and little marketing. Ripe fruit drops free when tipped up, and ripe pawpaw flavor is at its sweet custard best. If you let the fruit ripen in a warm dry house, you often have an over ripe "banana" with a harsh caffeine taste. This ripening is frustrating, achieving ripe fruit for the stand, but too ripe to ship.

B. As we go into pawpaw breeding it seems wise to gather selections which have no repellent green pepper flavor in fruit that is almost ripe. This should eliminate the need for much chemical change during ripening in a warm September, and most needed, less likely, complete ripening in the very cool days of October. Surprisingly, fruit can get knocked down too early, and ripen properly among downed pawpaw leaves, and grass under the trees. Pawpaws are said to ripen well when set into the oats in an oat bin. One would suspect that oats absorb enough of the ripening vapors to keep ripening a slow, mold free, snail free process.

C. Davis cross Overlease has produced seedlings with very large fruit and few seeds. We should repeat and expand these qualities. Doug Campbell's NC-1 pawpaw has this pedigree. The fruits are about one pound/.4 kg. with six to eight seeds, but late ripening in Niagara. Taytwo cross Overlease makes an early, large fruit. SAA Overlease is the earliest of the Overlease crosses, timed with Taytwo, SAA taytwo, and many Pa Golden.

Nut Pine Breeding

XVIII. Two nut pines deserve wider attention. Korean pine is hardy, growing north of Quebec City. It is native to Korea and Manchuria. Unfortunately, it does not survive on sweet garden soil. Pinyon pine from Colorado and New Mexico is much easier to start on sweet soils. It is a larger nut (smaller tree) than Korean, though only a large pea size. Pinyon hulls are thinner, and able to finger crack. Pinyon pines are less hardy than Korean pines, but hardy in southern Ontario on a deep gravel soil. Pinyon pines are difficult to transplant due to a spike root reminiscent of hickory.

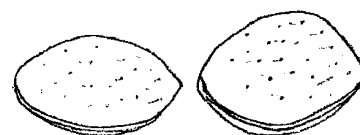
A. Charles Rhora of Wainfleet, Ontario is doing most of the work with nut pines. He produces good seed stands. His lake bed black silt-sand soil is acid enough to grow pine mycorrhiza. This soil grows a thin enough grass cover that mulches over-the-top like pine straw establishing the pine seed, and seedlings. Breeding may remain just growing our seed.

Almond Breeding

XIX. Titan and Hall's Hardy are the strains of almonds most often grown in our tender fruit areas. Their hard shells are like peach without peach seed look. Several Czech hardy almonds and Persian walnuts have hard shells. Hard shells and bitter kernels come out in many seedlings of almonds from northern Europe. Roadblocks in almond breeding are lack of hardiness, little resistance to plum fungi and viruses, and the need to emasculate because open pollination produces selfs. Ernie Grimo has a row of Czech almonds with thin shells with, which he is watching.

Sweet Kernel Apricot Breeding

XX. Apricots are hardier than almonds, but have the same breeding problems. Ernie Grimo has been emasculating, and crossing Vineland selections, and numbered trees with sweet kernels for years. Doug Campbell has been growing seed of his Reliable strain apricots, finding most have sweet kernels. I have tried his seedlings, but only American plum stands against virus here. They shed virus, but are too willowly to hold almond/apricot/plum up-right once their stocks are 2 in./5 cm. diameter, and the graft over-



Chestnut Bark Blight Breeding

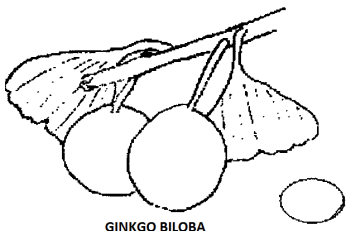
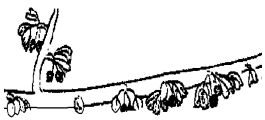
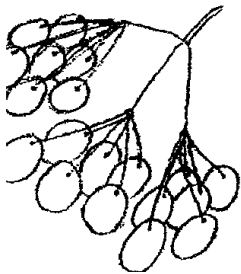
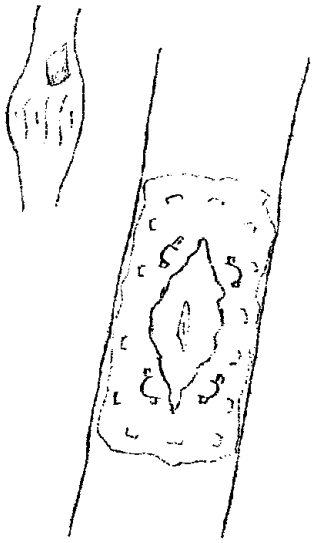
XXI. Chestnut blight can be found in most of our trees and orchards, despite eradication efforts. Because blight is as much a saprophyte as parasite, it is present on most decaying leaves, bark, and wood, which does not have to be chestnut. The effort to eradicate it does no good, but the effort to propagate a weakened, virus infected blight may be an adequate defenses for chestnut in humid, Lake moderated climates. Work at Michigan State University by Dr. Dennis Fulbright has shown seemingly resistant native groves in Michigan are maintaining weak blight, the kind of blight some pure Americans and most hybrids can fend off. The problem is passing the virus to all virulent blight races before a strong race kills the chestnut. The sexual stage of blight has to cross breed races that bond mycelial fans to pass along the virus. Weak blight is virus infected, recognized as swelling, non-girdling cankers on native chestnut. To use its best forms, in March cut into the bark and raise flaps in four directions from an advancing strong canker. If the inner bark is grey, rather than new leaf green, you are in the dead zone and have to move outward to cut another flap. Cut hunks of deep orange pustulated, lethal blight infected bark with some live bark from the puffed, enter light orange pustulated, non lethal canker bark. Deposit bark patches in the flap pockets. Staple 6 mil clear plastic over the inoculation, giving enough cover to slow drying of bark by one day after rain. Sexual reproduction of blight should proceed to destruction even if the canker races bonded spores only.

XXII. **Nanny berry** needs the removal of its large seed to make it a truly wild raisin. **Mulberry, Juneberry, and Autumn Olive** are being collected for evaluation where commercial. Juneberry (Saskatoon) is receiving attention for fruit and wine. Other sorts: **Beech, Siberian Stone pine, Western White pine, Cornus mas, Medlar, Elderberry,** etc. are selected for evaluation. An attempt at producing a **seedless pawpaw** is under way. Because pawpaw carries its mycorrhiza in its seeds, which look like colonies of cells as in a slime mold fruiting body, there may be an unforeseen conflict in stimulating fruit growth, as no seedless pawpaw fruit have been seen. **American and oriental persimmon** crosses are being attempted at Japanese and Russian research stations.

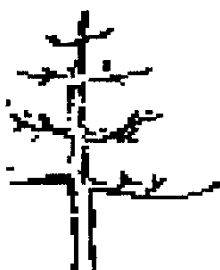
XXII. **Ginkgo nut trees are male or female.** Its form is copied into pagoda architecture. Like Elmer Myers black walnut, it has a strong central leader where main limbs sweep out from the central leader to form an open, airy structure. Ginkgoes females side bear all over yearly wood.

1. Most nut trees are terminal bearing on tip branchlets which extend many centimeters each year. In fact chestnuts need 8 in./20 cm. of growth out from burs/nuts to gather enough food to fill large nuts. Most apples bear on spurs which only extend 2 in./5 cm. in a year. Most nut trees are upland trees, more concerned with gathering health for an eventual fruitful year rather than setting up to bear each year from spur buds. We find **lateral bearing** in river flat trees where nutrients and moisture are adequate for annual bearing, and the buds in spurs are set by strong growth pushing the setting of flowers. That is why black walnut, shellbark hickory and pecan are often side bearing (or lateral bearing) trees for bumper crops. Ginkgo is the nut tree, which has mastered spur bearing a nut.

2. We are nut consumers, and want our nuts every year. This may not be possible because most nut trees need many centimeters of yearly growth to set flowers buds, manufacturing enough food to nourish vegetative growth, and nuts. Off years from stunted growth luckily BREEDING 165



GINKGO BILOBA



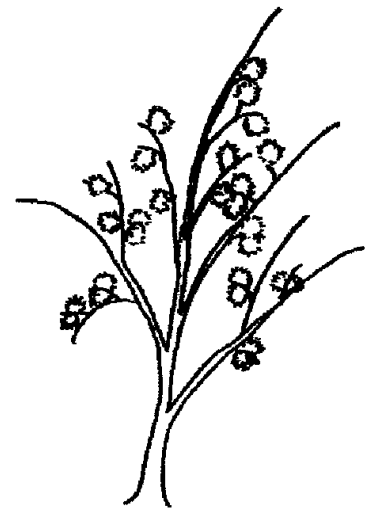
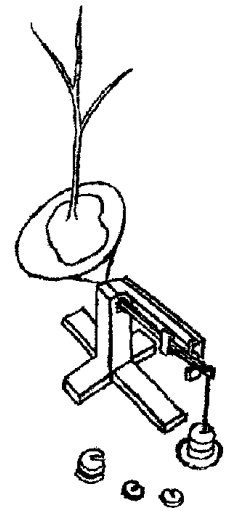
limit predator populations. The ancient ginkgo almost went extinct in recent times. Considering the cycle of bearing from branchlets, followed by their shade suppression, death and sloughing, one favors spur bearing on yearly wood for its economics. Persimmon trees side bear on new wood, but they drop much of the new wood with its fruit and leaves. Nut trees need natural renewal to produce regular crops, we hope yearly.

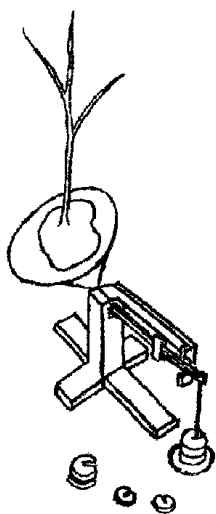
3. North American winters with their warm spells and cold snaps defeat the less hardy nut trees. Imported walnuts, filberts and chestnuts **suffer freeze-thaw injury**. None of the local American chestnuts have been defeated by cold snaps even in early October, but only a few American chestnuts can make inch nuts, and none are prolific producers.

4. Hybrids that are mainly American chestnut are unusual in that they bear inch nuts on the current season's flush of growth. New terminal growth should stop with enough energy to start seven catkins, **two with female bloom**, and with five full leaves above. There is controversy with some growers wanting chestnut to set many nuts like chinquapin, but these must be turkey hunters, wanting small nuts. Look for chestnuts that make commercial size nuts, crops, and health through consecutive cropping seasons. European sorts produce more crop, but our weather seems not to sustain crop, or tree.

5. European hybrid chestnuts differ from native in having a more stout terminal wood, which carries a larger crop of heavy nuts. The crop extends on green stems of current growth. The branch tips are star shaped cylinders of wood and bark over tri-cross star shape pith. This tree structure carries heavy nuts on many terminals which bend low in the final few weeks of the season. When these 3/8 in./1 cm. by 18 in./45 cm. terminals lose ability to renew, the whole tree declines to the ground in a cycle less than a decade. Persimmons drop of fruiting branches, or ginkgo side flowering without noticeable spurs is much more desirable. Virus clogging sap tubes in Persian walnut may be due too weak juglone. The fast growing European chestnut hybrids fail though ginkgo and Japanese hybrids live leaner, live in cold weather, and live long.

6. The young **Heartnut bearing is like Chestnut large nut bearing** in that it bears on large terminals which keep extending the vegetation of the tree. Heartnut sets its cluster at the fifth leaf out though this is hard to notice because the stem extends after the nutlets flower, and the leader peels off from the flower stub, leaving the stub behind with some leaves to feed the nut cluster while the terminal is projected out another ten leaves to feed the tree. Heartnut must have the right type of Juglone. The cluster of heartnuts may weigh a pound. The new branch which supports the leader and the cluster is several centimeters thick. Heartnut branches bend, but do not break in the wind. Heartnut has many growing-flowering tips throughout its canopy. Each support a cluster of nuts except where an insect bores the center of stem below the flower, and the flower aborts. The nuts are usually well filled, except many aborted for no apparent reason in heartnut hybrids.





Most continue to find light as the center of the tree opens up as the leaning trunks, and limbs bend down under loads of wind, nuts, and own limb weight. Heartnut seldom grows a vertical trunk as its center-of-tree bends to effectively to open it to light. Pruning has to remove low limbs, and even major stems as the tree ages.

7. Persian walnut does not grow like a heartnut. It grows a vertical leader. It suffers all types of cold and frost injury. Once heartnut has produced green leaves, these are subject to freeze injury. Once Persian walnut swells its buds these are killed in the core by a frost. It is as though Persian walnut in spring has become a subtropical tree. Cycles of freezing usually end bearing for that season. Persian walnut sap must be low in sugar to freeze so easily. To stop sap flow Persian walnut shades its bark from the sun with clusters of branchlets. The branchlets, many of which are dead, or dying, cover the major branches as well as the trunk. Walnut blight lodges in the dead and dying branchlets, and feeds on them, waiting to splash to new growth and enter it. A drip of dew on the base of a nut is the usual site of a blight canker. Carrying these injuries, it is difficult to expect good cropping, but there is enough cropping to keep growers interested.

8. If Persian walnuts can be kept in a healthy condition, many branchlets will crop. Several are lateral bearing on the side buds of vigorous terminals (Hansen and Manregion). Although side bearing Persians consistently produce nuts on spurs above second year wood the ratio of leaf to nut is low, yielding smaller nuts. Side bearing trees are usually weak from cropping, winter injury, and blight. They must be pampered with cultivation, spraying, feeding, pruning, irrigation, and selection which need Lake shore growing.

9. Tree filbert hybrids are similar to heartnut because they are semi-hardy compared to American natives, and their major limbs lean wide to open the center-of-tree to light. Hybrid selections have the melting kernel of tree hazel, and can be grown single stem for shaking. Eastern Filbert Blight resistance, and bud mite resistance, are showing some progress. Few of today's hybrids have the winter hardiness and dormancy of native hazel, but it is adequate, or continues to accumulate with tree height.

10. American chestnut trees receive the most attention as people seek to preserve this once commercial tree. Their most ambitious advocates are landscapers seeking estate trees, and forestry oriented nut growers. They picture chestnut as a clean, fast growing, ornamental tree and log, very competitive in the forest, and on many fields.

XXIV. Conservation plantings seem to be the most likely sites to grow a large number of nut trees as agroforestry. They enjoy scientific interest: biology, agroforestry with native nuts, and nutrition. We would like a mix of good nut trees and people doing yearly planting so that there is a next generation of each.

XXV. Effort put into research leading to an improved fruit is done happily for the greater good. A great deal of soul searching comes out at grower meetings about species which merit much more interest than they got. Japanese heartnuts and Manchurian walnuts are woefully overlooked, misunderstood, and neglected. When valuable trees surface, as they do in most nut species, we know these species were too much neglected in the past, and hope for the work that makes them a success in the future.

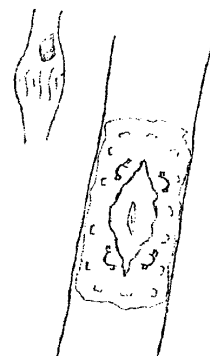
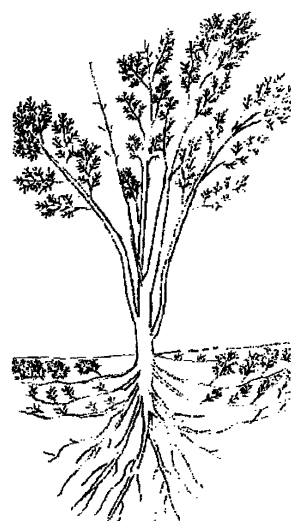
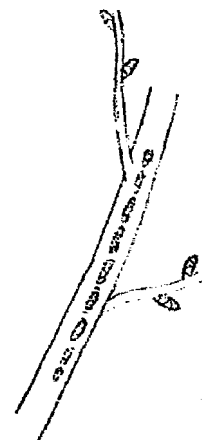
XXVI. To Conclude; the progress we make in nut growing is built on the progress we make in nut trees. Good nut trees are a fascination. However, current trees are temporary even in nature's plan. Growers are looking for a workable program of making select trees. Select seed is tried by several small nurseries, something like five nut lines in five species. Getting the select seedlings out to nut growers, conservation plantings, and forestry is ages old, and still on life support. American chestnut plantings on public land is currently a success due to much effort, and will eventually bring back the American chestnut. We hope to get forestry interested in planting American chestnut. Nuts are interesting to children of all ages. After we have a working group, and a planting set out to point to, we have to produce an educational packet to use in schools to produce seedlings in a continuing cycle of education, and grower support. The native chestnut is the local, touchable, endangered species.

A. Humans are superheroes? Not quite. Humans are super organisms. Scientific American has it that there are 10 times the number of "foreign" cells (trillions of cells) organized in a human body than human cells. Trees have 10,000 species of foreign species in each tree. Pawpaw carries its mycorrhizal base within its seed. Babies gain most of their "foreign" cells from close association with their mothers. How do trees get them? More important, what chemicals do trees make to keep foreign cells in check. Willow trees make salicylic acid, which stops foreign cells from clumping together like slime molds do to drive into tree tissues. When a foreign organism evolves to attack a species of tree, the result can be the elimination of that tree from our forests except for a few trees, which seem highly resistant, but were skipped due to isolation. Isolation from blight is temporary, but kept from evolving against the blight, we hope blight evolves away from its parasite form. Interesting that humans also take salicylic acid to keep cancer tumors from sizing.

B. Look at what happened between Filbert and Autumn Olive. Eastern Filbert Blight, and a similar black pustule disease of Autumn Olive, met in this planting. After most individuals developed cankers, and died, the blights died off both. All the Filberts and Autumn Olives shed their cankers. It seems like a symbiotic organism was waiting in their organs to be triggered into action.

C. We have been working for decades to get the white fungus that lodges in crevasses of gnarled, but living, chestnut bark on old, weathered American chestnuts to stop making large cankers. Some times it did, but was too weak to spread in dry weather, whereas chestnut blight could. Even the weakened forms of blight (hypovirulent chestnut blight that is infected by a virus) would not spread here. Hybridizing, breeding, engineering, and symbiosis should lead to successes. The College of Environmental Science and Forestry at Syracuse University is now starting test plantings of very blight resisting American Chestnuts which contain packets of resistance genes (packets from mainly food plants are on trial as gene donors). The New York Chapter of the American Chestnut Association is a cooperator to evaluate trees, which will require general release permits. Prior work engineered elm tree canker resistance, and now help is needed with the Thousand Canker Disease of black walnut, which is working its way out of the US Southwest.

XXVII. Who should do research on these species? 90% of astronomic discoveries are from amateur astronomers. I mentioned that while pecan exploring I met with scientists sent to get northern nut germ plasm for their hickory bank, and not willing to seek out the select material, but get edge of grove "**farthest north genetic material**". Very well, collecting a few northern genes should be expected from pecan growing states of Georgia and Texas. However, it is like putting the welfare of mustangs in the care of the Bureau of Land Management; too cattlemen serving. Heartnut comes to mind. Lobbying brings its friends, look at national health care vs. natural medicine. If we cannot verify nut improvement the lines needed for sustained improvement will be lost as many have been in the past. How do the groups that license research make sure that research is to the greatest good? The amateur groups have to pass on interest in nuts, growing methods, and good contacts for our own lobbying.



10-10-10, 12-12-12, 15-15-15 (granular fertilizer; % nitrogen to % phosphorus to % potassium in container.)

Buy the most economic knowing that spread is keyed on nitrogen. A 2 lb. can of 10% N is spread on 4x shadow area of a 1 in. diameter tree is .2 lb. actual nitrogen (.2 lb., .24 lb., .3 lb., N /granular rate.)

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METRIC...ENGLISH Conversion (Farming)

Metric... English

1 m. = 3.28 ft.

1 cm. = .39 in.

1 mm. = .63 sixteenth in.

1 kg. = 2.2 lb.

1 l. = 1.06 qt. (US) = .88 qt. (UK)

1 ha. = 2.471 ac.

1000 kg./ha. = 405 kg./ac. = 891 lb./ac.

The temperature , °C = $\frac{5}{9}$ [temperature °F -32]

The temperature , °F = $\frac{9}{5}$ [temperature °C] +32

1000 lb./ac. = 454 kg./ac. = 1122 kg./ha.

1 ft. = .3 m.

1 in. = 2.54 cm.

1/16 in. = 1.6 mm.

1 lb. = .454 kg.

1 qt. (US) = .95 l. = .83 qt. (UK)

1 ac. = .405 ha.

ac. acre

C Celsius, Centigrade 0°C /32°F

cm. centimeter

F Fahrenheit 0°F /-18°C

ft. foot

g. gram

ha. hectare

in. inch

kg. kilogram

l. liter

lb. pound

m. meter

mg. milligram

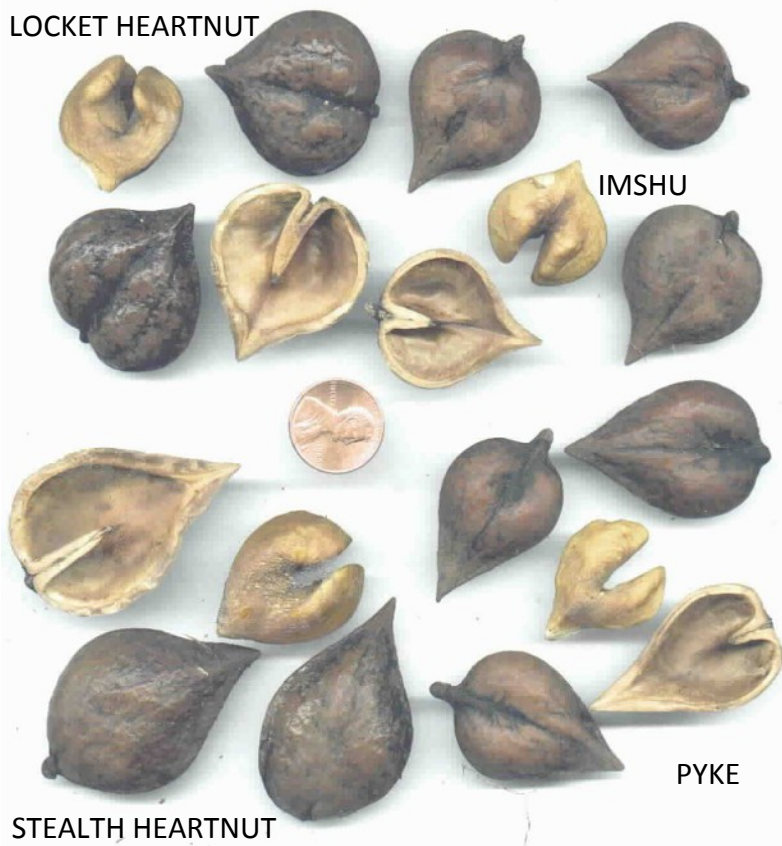
mm. millimeter

qt. quart

° degree

10^4 = 10k = 10,000.

LOCKET HEARTNUT

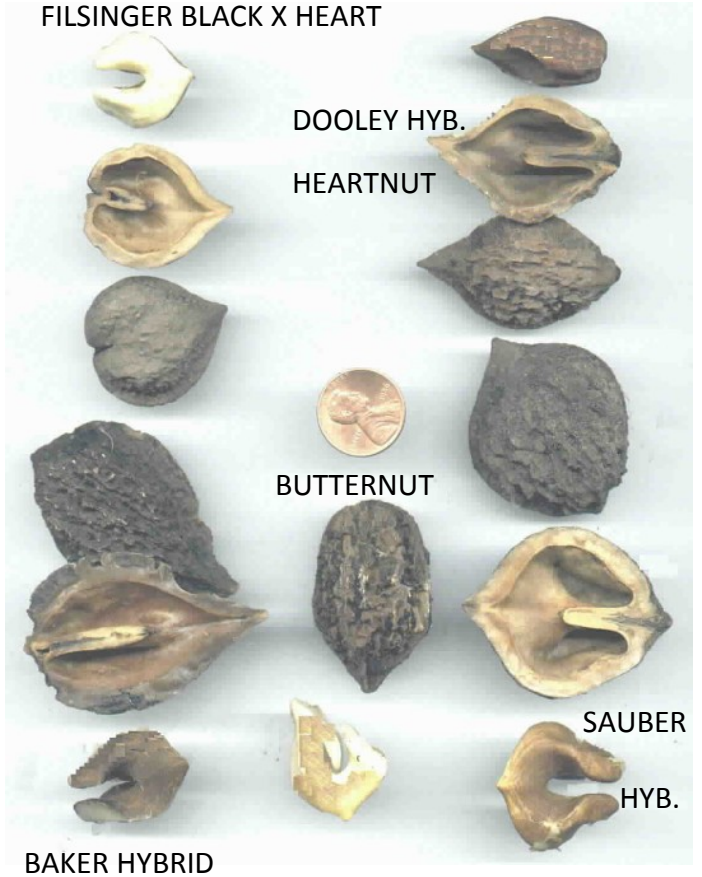


IMSHU

STEALTH HEARTNUT

PYKE

FILSINGER BLACK X HEART



DOOLEY HYB.

HEARTNUT

BUTTERNUT

SAUBER

HYB.

BAKER HYBRID

FAYETTE SHELLBARK

HENRY SHELLBARK



WAGNER SHAGBARK HICKORY

NC-I SHELLBARK

WESCKE SHAG

DRAVIS' DOGHOUSE SHELLBARK HYBRID

BLUNT HEARTNUT

SCHUBERT



COVEL

MANCHURIAN

CW3

VIEW www.nuttreesnorth.com/book210/book210.pdf FOR BEST DIGITAL PICTURE.

BACK COVER, BACK



ABBOTT BITCAN

HENKE HICAN

YODER 1 SHAG

BURTON HICAN

GOOD SHELLBARKS



GLOVER SHAG

SNAPS PECAN PC-101



SLATE HYBRID FILBERT



CARROLL PERSIAN WALNUT



VIEW www.nuttreesnorth.com/book210/book210.pdf FOR BEST DIGITAL PICTURE.



SIMPSON HYBRID

RIDGE HYBRID

BACK COVER, NUT GROWING ONTARIO STYLE

EMMA K



OHIO BLACK WALNUT

