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Organic Chinese Chestnut Production in Virginia

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TABLE OF CONTENTS

<i>I. INTRODUCTION</i>	<i>3</i>
<i>II. ESTABLISHMENT</i>	<i>3-5</i>
SITE SELECTION AND PREPARATION.....	3
ORCHARD SPACING.....	3
PLANTING STOCK.....	4-5
<i>III. MAINTAINANCE</i>	<i>5-8</i>
FERTILIZATION.....	5
PRUNING.....	5-6
WEED CONTROL.....	6-7
PEST AND DISEASE CONTROL.....	7-8
<i>IV. HARVEST</i>	<i>8-9</i>
MANUAL HARVEST.....	8
MECHANICAL HARVEST.....	8-9
POST-HARVEST HANDLING.....	9
<i>V. MARKET</i>	<i>9-10</i>
CONSUMER PREFERENCES.....	9
MARKET OUTLETS & PRICES.....	9-10
<i>VI. CONCLUSION</i>	<i>10</i>
<i>VII. ACKNOWLEDGEMENTS</i>	<i>10</i>
<i>VIII. REFERENCES</i>	<i>10-12</i>
<i>IX. APPENDIX A: ADDITIONAL RESOURCES TOOLBOX</i>	<i>12</i>
PRODUCTION.....	12
MARKETING.....	12
<i>X. APPENDIX B: CHESTNUT NETWORKS</i>	<i>13</i>

Introduction

The mighty American chestnut tree was once a dominant figure in hardwood forests throughout the eastern United States. An iconic source of food, chestnuts were sold by the ton every year, until the chestnut blight nearly brought this tree crop to extinction in the early to mid-twentieth century. Although this nut has seemingly all but disappeared from the American diet (Wahl 2002a), consumer interest and demand is on the rise once more and the opportunity for commercial Chinese chestnut production in Virginia is increasingly apparent (Gold et al. 2006, Aguilar et al. 2009, Cernusca et al. 2012).

This publication serves as a “how to” guide for establishing, maintaining, harvesting and marketing chestnuts organically in Virginia. Recommendations are based on interviews and orchard visits with established regional chestnut growers and researchers, as well as a literature review of journal articles pertinent to chestnut production in the United States. Additional resources highlighted in this publication include planting stock sources, grower networks, orchard design templates and enterprise budgets.

Establishment

Site Selection and Preparation

Choosing a well-suited site for chestnut orchard establishment is the first and most important step. If an incompatible site is chosen, the orchard’s survival and vigor will be compromised (R. Stehli, personal communication, May 9, 2015).

Chestnuts require sandy-loam soils with a pH of 5.5-6.5 and full sun for optimal nut production. Planting sites should be located on a summit or shoulder slope to

ensure adequate drainage and protection from frost (Hunt et al. 2012).

To prepare the site for establishment, organic herbicides can be applied within the rows to reduce weed competition. A subsoil plow set at 36” deep can then be used to turn up the soil, followed by discing to loosen large soil clumps and finally a box blade to level the ground for planting (G. Miller, personal communication, May 9, 2015).

Orchard Spacing

There are a variety of spacing options for chestnuts depending on orchard objectives. If space is limited and high early yields are desired, chestnut trees can be planted at 20-30’ X 20-30’ spacing. As tree branches begin to touch around year 15, the orchard should be thinned to every other tree to reduce shading and overcrowding, which causes lower branches to die (Hunt et al. 2012).

If minimizing labor is desired, chestnut trees should be planted at 40’ X 40’ spacing (Figure 1). Although high early yields are diminished, the need for thinning and excessive pruning is reduced (G. Miller, personal communication, May 9, 2015).



Figure 1 Chestnut Spacing at 40’ X 40’

Planting Stock

Grafted Trees

Chestnut planting stock is available in many forms, although grafted containerized trees can be the quickest way to establish an orchard for commercial nut production. Planting stock is relatively expensive (\$17-\$40 depending on size), but production begins only 2-3 years after planting with up to 2,000 lbs/acre by year 12-15 (Hunt et al. 2012). The grafted cultivars offer the predictability of yield, nut size, color and quality, time to production and ripening times (Payne et al. 1983).



Figure 2 Delayed Graft Failure

However, delayed graft failure (Figure 2) rates as high as 50-80% have been reported in trees 1-30 years old (G. Miller, personal communication, May 9, 2015). Failure tends to increase when trees are under stress from transplant shock, inclement weather or poor site conditions. Spring planting of grafted trees and a modified two-flap graft in spring as bud break begins has been shown to decrease graft failure (R. Stehli, personal communication, May 9, 2015).

The following Chinese chestnut cultivars have been successful in commercial orchards and cultivar trials and are recommended for nut production:

Recommended Cultivars

1. **Gideon** is a spreading, cold hardy Chinese cultivar that produces attractive, easy to peel, uniform nuts that average 28-39 nuts/lb. Nuts are harvested beginning early October (Hunt et al. 2012), with high, reliable yearly yields even in sub-optimal weather (H. Craddock, personal communication, February 25, 2015).
2. **Sleeping Giant** is a Chinese-Japanese-American hybrid cultivar that produces an attractive and flavorful light brown nut of excellent quality. With an early harvest occurring the last week in August of roughly 28-35 nuts/lb, this cultivar can sometimes produce a second harvest in October (H. Craddock, personal communication, February 25, 2015). This large upright tree is often grown for timber, as well (Hunt et al. 2012).
3. **Shing** is a vigorous high-yielding Chinese cultivar that produces misshapen, but good tasting nuts. Its large upright form makes it suitable for timber production, as well (H. Craddock, personal communication, February 25, 2015).

Bare Root Seedlings

Seedlings with known mother cultivars can also be planted in the spring. Since the father tree often remains unknown, seedlings offer less predictability than grafted trees. However, hardy seedlings are found in the majority of commercial chestnut orchards in the U.S. today, with

survival rates as high as 95% reported. With an average cost of \$4-\$8/tree for one to two year seedlings, start-up costs remain low (G. Miller and R. Stehli, personal communication, May 9, 2015).

Scion wood from recommended cultivars can be field grafted to 1-2 year old seedlings, with nut production ensuing one to three years after (Hunt et al. 2012). Excessive rainfall after grafting and poor site conditions can increase tree stress that leads to graft rejection (R. Stehli, personal communication, May 9, 2015). Since success rates vary drastically across sites and among cultivars, only experienced grafters should take on this method of establishment.

Seeds

Seeds are the most cost-effective option for orchard establishment. Stratified nuts from recommended parent cultivars can be purchased for only \$14/35 nuts. The seeds can be planted in plowed rows with tree tubes and mats to suppress deer pressure and weed competition. With known cultivated parent trees, these seeds offer the same predictability as grafted trees, but with increased delay of nut production and associated profits (G. Miller and R. Stehli, personal communication, May 9, 2015).

Chinese Chestnut Nurseries

Empire Chestnut Company

3276 Empire Road SW,
Carrollton, OH 44615
330-627-3181
empirechestnut@gmail.com
<http://www.empirechestnut.com/>

Forrest Keeling Nursery

88 Forrest Keeling Lane,
Elsberry, MO 63343
800-FKN-2401

info@fknursery.com
<http://www.fknursery.com>

Nolin River Nut Tree Nursery

797 Port Wooden Road,
Upton, KY 42784
270-369-8551
john.brittain@windstream.net
www.nolinnursery.com

Maintenance

Fertilization

Soil tests should be taken regularly to determine annual soil amendment needs and application rates. If the site has a high pH, elemental sulfur can be applied to moist soil to lower pH levels (Barney p. 94). Similarly, if organic matter concentrations are below four percent, blood meal can be applied within the dripline during tree establishment to quickly release nitrogen. Moderate levels of slow release nitrogen are also available from alfalfa straw and meal, compost and manures, feather meal, fish emulsion and meal and cottonseed meal. Alternatively, clover, beans and peas can be grown prior to establishment and turned into the soil as a green manure crop (Barney p. 100). Adequate nitrogen will encourage good annual tree growth of 18-24 inches in young trees and 12-15 inches in fruiting trees (Hunt et al. 2012).

Pruning

Although mature trees involve very little pruning, young trees require some training to ensure proper structure. Stake young trees to train upright growth and a central leader structure.

Once production begins, low limbs should gradually be pruned so an orchard mower and sprayer can maneuver around each tree (G. Miller and R. Stehli, personal

communication, May 9, 2015). Weaker branches should also be pruned to avoid breakage during heavy fruiting, ice and snow (Hunt et al. 2012).

Weed Control

To suppress weed competition of light, water and nutrients, it is important to actively manage for weeds using a combination of organic controls. A decrease in yield and nut quality can result if competition is allowed to persist (Rowley et al. 2011). During the growing season, frequent mowing in rows and in between trees will combat competition temporarily. Mowing can also be combined with the following organic weed management techniques:

Tillage

Soil tillage is the most common organic weed management technique used in commercial orchards today. This effective and affordable method not only reduces weed competition, but also rodent habitat. Tillage during the winter months using precision equipment like the Wonder Weeder will reduce potential negative impacts like root damage and loss of organic matter (Granatstein and Sánchez 2009).

Flaming

Steam and flame weeding have been found to control 95% of weeds one week after application, with suppressive effects remaining for up to three to four weeks. As a result, treatments, averaging \$30/acre for propane, will need to be applied monthly for best weed control (Shrestha et al. 2012). This low cost makes flaming a viable option.

However, care should be taken not to damage trees and irrigation system during treatment. Since flame and steam

are less effective at combating mature weeds and perennials, it may be best to begin treatments early on in the season to prevent weed maturation (Granatstein and Sánchez 2009).

Herbicide

There are only a handful of herbicides that are compliant with organic standards, including acetic acid, lemon grass oil and clove oil. Unfortunately, they are considerably more expensive than conventional herbicides and are not consistently effective in controlling weeds unless applied frequently and at a high rate (Rowley et al. 2011).

D-limonene, for example, has effectively controlled 95% of weeds within the first week of application, but needs to be reapplied every five to six weeks for continuous weed control. At \$111/acre, this can add up quickly (Shrestha et al. 2012). If applied broadly, rather than in spot treatments, acetic acid can cost up to \$144/acre, lemon grass oil up to \$130/acre and clove oil up to \$171/acre. To reduce costs, it is recommended to apply herbicide in spot treatments in conjunction with mulch (Rowley et al. 2011).

Mulching

Mulching can significantly increase tree growth and productivity by suppressing weeds, retaining moisture and adding nutrients. Wood chips, for example, have been shown to suppress weeds for up to three years, while also decreasing watering needs. Similarly, hay and straw mulch has been shown to increase fruit size (Granatstein and Sánchez 2009) and effectively suppress weeds (Rowley et al. 2011). Since chestnuts prefer a slightly acidic soil, local sources of pine straw could be gathered and used as a free

source of mulch. Grass, alfalfa or legumes within the alleyways can also be mown and dispersed into the tree rows as a free, on-farm mulch and a source of nitrogen (Granatstein and Sánchez 2009).

There are several limitations of mulch to consider, however. It's important to lay mulch down prior to weed development and select those free of weed seed. Over time, however, wind or tractor carried seeds can voluntarily grow within the mulch, making it necessary to supplement with spot applications of herbicides (Rowley et al. 2011). Mulches can also unintentionally create ideal vole habitat and too much water retention can lead to *Phytophthora* root rot (Granatstein and Sánchez 2009).

If purchased, mulch can quickly become expensive; up to \$239/acre of straw and \$717/acre of wood chips. This can add up if reapplied every one to two years for best results. The affordability of mulch will largely depend on availability of local and free resources (Rowley et al. 2011).

Pest and Disease Control



Figure 3 Deer Fencing

Deer have been known to kill young trees due to browsing and antler rub, and reduce harvest yields as much as 600 lbs/acre (R. Stehli, personal communication, May 9, 2015). As a result,

8' woven wire fencing with an electric strand on top should be installed to keep deer out of the orchard (Figure 3). Materials for fencing cost approximately \$1,992 per acre, but provide long lasting benefits (M. Gold, personal communication, February 24, 2015).

Small and large chestnut weevils are the most common insect pests. They surface from the soil and oviposit eggs inside of the chestnut where larvae feed on the nut. Once mature, the larvae will leave the nut and return to the soil, where it will emerge one to three years later to restart the cycle. This makes them one of the most devastating pests to commercial nut production. Fortunately, populations were dramatically reduced as a result of the chestnut blight (Hunt et al. 2012). If an infestation does occur, however, it is essential to stop the cycle by quickly harvesting fallen nuts before weevils hatch and burrow into the soil once more (Keesey and Barrett 2008).

Potato leafhoppers emerge May-June and prey on the veins of leaves. The result is leaf deformation and defoliation that reduces nut yield and quality (Hunt et al. 2012). Organic pesticides, such as Pyganic and Neemix, and insecticidal soaps can be applied to the foliage with an orchard sprayer. Pyrethrin, a primary compound in Pyganic, is also known to kill weevils (R. Stehli, personal communication, May 9, 2015).

Oriental chestnut gall wasp is a pest that was introduced to Georgia and has since made its way to Virginia. Eggs are deposited into chestnut buds, forming galls (Figure 4) that disrupt shoot growth and survival (Hunt et al. 2012). Death can result in young trees, while yield can be reduced as much as 50-75% in mature

trees for several years (Payne et al. 1983). Biological control from parasitic wasps, which are present in Virginia, is the only form of control at this time (G. Miller, personal communication, May 9, 2015).



Figure 4 Galls from Chestnut Gall Wasp

Phytophthora root rot is a devastating disease that attacks and kills the root zone, spreading underground from one tree to the next. It is recommended to purchase trees from a single nursery source free of root rot. A combination of gypsum and chicken manure have been found to reduce root rot in evergreens, and is now being tested on chestnuts (R. Stehli, personal communication, May 9, 2015).

Harvest

Chinese chestnuts will drop nuts for a two to four week period from September through November (R. Stehli, personal communication, May 9, 2015). Exact timing depends largely on the weather and cultivar. Chestnuts can be harvested using two methods -manual and mechanical- depending on orchard size.

Manual Harvest

Manual harvest is manageable and ideal for orchards under three acres (D. Fulbright, personal communication,

March 10, 2015), unless ample labor supply is present. One person can harvest up to 30 lbs of chestnuts in one hour. With an average payment rate of \$0.36-\$0.50/lb and mature yield at 1,500-2,000 lbs/acre, manual harvest costs average \$753/acre (G. Miller, personal communication, May 9, 2015).

Alternatively, a manual nut-harvesting tool called the Nut Wizard can be purchased for only \$65. It has the ability to harvest a mature acre of 2,000 lbs for \$600 with labor costs at \$8 per hour (Warmund et al. 2012). Since chestnuts have high water content, they should be harvested every other day to prevent rot and predation from wildlife (G. Miller, personal communication, May 9, 2015).

Mechanical Harvest

As an orchard reaches 25 acres and up, high-volume nut production makes manual harvest impractical for those without an adequate labor force. Instead, mechanical chestnut harvesters can be purchased. Although, the Italian FACMA Vacuum Harvester costs anywhere from \$65,000-\$80,000 depending on the model, it can harvest 8,000 lbs of nuts daily and has the ability to separate burs from nuts (D. Fulbright, personal communication, March 10, 2015).



Figure 5 Harvestable chestnuts in the bur

Greystone Vacuums offers a more affordable Maxi Vac (Figure 5) for \$4,700, which can harvest approximately 17,600 lbs of nuts in 340 hours for \$4,622 with labor costs at \$8 per hour. This vacuum does not sort burs and debris from the nut, so labor requirements post-harvest increase. Since harvesting can account for half of the operating costs of a chestnut orchard, it's important to consider availability of labor and the time efficiency and costs of various harvest methods (Warmund et al. 2012).



Figure 6 Greystone Vacuum's Maxi Vac on a raised trailer (Warmund et al. 2012)

Post-Harvest Handling

Harvested chestnuts should immediately be placed into a hot water bath at 118 degrees Fahrenheit to kill weevils (G. Miller, personal communication, May 9, 2015). After washing, chestnuts should be air dried, placed into gallon Ziploc bags and stored in the refrigerator at 32 degrees for up to three months (Warmund 2011). Since water decreases the sugar content of chestnuts, they should be held for at least ten days before selling to recover the sweetness (R. Stehli, personal communication, May 9, 2015).



Figure 7 Hot water bath (right)

Market

Consumer Preferences

Understanding consumer awareness of and preferences for chestnuts is critical for successful marketing ventures. In general, chestnuts are not well known among consumers, particularly their nutritional benefits, where to purchase them, and how to store and cook them (Gold et al. 2005). In one study, although the majority of participants had previously purchased chestnuts and were familiar with roasting them, most were unfamiliar with cooking them and consumed them less than once a year (Cernusca et al. 2012). Outreach events, like the Missouri Chestnut Roast, have been linked to increased chestnut interest, consumption and awareness over time (Cernusca et al. 2008), but more consumer education is needed throughout the U.S. to increase the success of chestnut businesses (Gold et al. 2006). Growers who direct market could benefit from providing educational information about chestnut nutrition, storage and preparation to consumers, as enhanced purchase satisfaction has been shown to encourage continued purchases (Cernusca et al. 2012).

A variety of other studies have been conducted to determine U.S. consumer preferences for chestnuts, which can also be used to guide successful marketing (Wahl 2002a, Kelley and Behe 2002, Smith et al. 2002, Gold et al. 2004b, 2005, Aguilar et al. 2009, Cernusca et al. 2012). In one study, locally grown labels, followed by medium to large chestnut sizes and organic certification influenced chestnut purchases the most, while price had the least impact (Aguilar et al. 2009). Another study found that consumers are willing to pay more for chestnuts produced from a cultivar with a brand name and organic certification (Gold et al. 2004b, 2005). Studies on upscale restaurants found a preference for fresh, high quality value-added chestnut products (Wahl 2002a) and peeled chestnuts among chefs (Kelley and Behe 2002, Smith et al. 2002).

Market Outlets and Prices

Most chestnuts in the U.S. are sold locally, with on-farm sales the most preferred, followed by upscale grocery stores, farmer's market, distributors and restaurants. The price range within each market outlet varies drastically, with locally grown, organic chestnuts produced from cultivars and advertised with a well-known brand name obtaining the highest price tag.

Restaurants pay the highest price for chestnuts at \$2-\$7/lb, followed by health food stores at \$2-\$6/lb, online customers at \$1.85-\$6/lb, on-farm sales at \$1.50-\$6/lb and farmers markets at \$0.75-\$6/lb (Gold et al. 2006). Ultimately growers will need to assess the best marketing outlets and prices for their area, as market knowledge is a key ingredient to a successful chestnut business (Gold et al. 2004a).



Figure 8 Chestnuts ready for market

Conclusion

High commodity prices, increasing consumer demand and relatively low start-up costs make commercial chestnut production an appealing venture (Gold et al. 2006). Compatible site selection coupled with recommended maintenance can produce a healthy orchard ripe for picking. With a sufficient understanding of consumer preferences for and awareness of chestnuts, marketing is made easy and profitable.

The inputs outlined in this publication can be used as a guide for establishing, maintaining, harvesting and marketing a commercial Chinese chestnut orchard for organic nut production. If crossbreeding efforts are successful, this guide could also be used for an American chestnut orchard in the future.

Acknowledgements

The authors would like to thank John Seiler, Virginia Tech; Hill Craddock, University of Tennessee, Chattanooga; Adam Downing, Virginia Cooperative Extension; and Kyle Peer, Virginia Cooperative Extension, for their assistance in the review process. We would also like to thank Greg Miller, Empire Chestnuts; Robert Stehli, Wintergreen Tree Farm; Michael Gold,

University of Missouri, Center for Agroforestry; Dennis Fulbright, Michigan State University; and Hill Craddock, University of Tennessee Chattanooga, for sharing their in depth knowledge on chestnut production. Without their valuable experience and research, this publication would not be possible.

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Appendix A: Additional Resources Toolbox

This section provides additional resources for establishing, maintaining, harvesting and marketing chestnuts. Additional information about the resources cited below can be found in the references section.

Production

- How to guides for nut production: "Nut Grower's Guide: The Complete Handbook for Producers and Hobbyists" (Wilkinson 2005) and "The Home Orchard: Growing Your Own Deciduous Fruit and Nut Trees" (Ingels et al. 2007).
- Details on Chinese chestnut production in Missouri (Hunt et al. 2012): <http://www.centerforagroforestry.org/pubs/chestnut.pdf>.
- Chestnut production tips from a case study orchard in Iowa (Wahl 2002b): http://www.agmrc.org/media/cms/The_Chestnut_Primer_2002_90B857872BE60.pdf
- Guide to training and pruning orchard trees (Olson 2011): <https://catalog.ext>

ension.oregonstate.edu/files/project/pdf/pnw400.pdf

- Chestnut weevil management tips (Bessin 2003): www.uky.edu/Agriculture/Entomology/entfacts/fruit/ef206.htm

Marketing

- Consumer preferences for chestnuts: “Exploratory assessment of consumer preferences for chestnut attributes in Missouri” (Aguilar 2009); “Post-purchase evaluation of US consumers’ preferences for chestnuts” (Cernusca et al. 2012); “Update on consumers’ preferences for chestnuts” (Gold et al. 2005); and “Chef’s perceptions and uses of colossal chestnuts” (Kelley and Behe 2002).
- Chestnut market analysis: “Competitive market analysis: chestnut producers” (Gold et al. 2006).
- Chestnut marketing brochure with nutritional and preparation information: <http://www.centerforagroforestry.org/pubs/whychestnuts.pdf>.
- Information card for chestnut buyers: <http://www.centerforagroforestry.org/pubs/infocard.pdf>.
- Enterprise budget to estimate profits: University of Missouri, Center for Agroforestry’s Chinese Chestnut Decision Support Tool- <http://www.centerforagroforestry.org>.

Appendix B. Chestnut Networks

The following networks can provide the mentoring needed to get your chestnut orchard started, as well as the latest research on chestnut production and marketing.

Grower Networks		
Network Name	Website	Email
Chestnut Grower’s of America	http://www.chestnutgrowers.com	CGA-Info@ChestnutsOnLine.com
Northern Nut Grower’s Association, Inc.	http://www.northernnutgrowers.org/index.html	tuckerh@epix.net
Michigan Nut Grower’s Association	http://www.michigannutgrowers.org	edemco@netonecom.net
Iowa Nut Grower’s Association	http://iowanutgrowers.com/nuts-in-iowa.html	info@iowanutgrowers.com

Chestnut Researchers			
Name	University	Email	Phone Number
Hill Craddock	University of Tennessee, Chattanooga	Hill-Craddock@utc.edu	423-425-4643
Michael Gold	University of Missouri, Center for Agroforestry	GoldM@missouri.edu	573-884-1448
Dennis Fulbright	Michigan State University	fulbrig1@msu.edu	517-353-4506