



# Great Lakes Fruit, Vegetable & Farm Market EXPO Michigan Greenhouse Growers EXPO

December 6-8, 2011

DeVos Place Convention Center, Grand Rapids, MI



## Chestnut Production

**Where:** Gallery Overlook (upper level) Room E

**Moderator:** Mira Danilovich, Michigan Chestnut Advocate, Detroit, MI

- 2:00 pm      Commercial Chestnut Production--Ready for Prime Time
- Dennis Fulbright, Plant Pathology Dept., MSU
- 2:35 pm      Can North America Grow Tasty Chestnuts? A Descriptive Sensory Analysis of Chestnut Cultivars Grown in North America
- Michele Warmund, Plant Sciences Dept., Univ. of Missouri
- 3:05 pm      Commercial and Research Opportunities for Chestnut Harvest
- Dan Guyer, Biosystems and Agricultural Engineering Dept., MSU
- 3:35 pm      Current and Developing Chestnut Markets in North America
- Roger Blackwell, Chestnut Growers, Inc., Grand Haven, MI

## Commercial Chestnut Production—Ready for Prime Time

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The long-term objective of the Chestnut Research Team at Michigan State University has been to assist the young, pioneering chestnut industry during its 10-year transition into a highly respected, professional, and entrepreneurial commercial food industry. We approached this objective by focusing on the four goals listed below:

- 1) Improve germplasm and assist growers with site selection;
- 2) Develop pertinent information for growers dealing with the horticultural care of trees and orchards;
- 3) Determine needs of growers at harvest while maintaining the quality of chestnuts during storage; and
- 4) Work on product development and enhancing markets.

Each of these four areas appeared daunting at the outset, but with help from the growers, MSU Project GREEN, the Ernie and Mabel Rogers Endowment, MSU Product Center for Agriculture and Natural Resources, MSU AgBioResearch, MSUE, Michigan Department of Agriculture, USDA Rural Development, and USDA Marketing Services, chestnuts have progressed and many believe the industry has transitioned into becoming a realistic commercial industry.

This is one of the reasons we are here at the Great Lakes Expo. We have never been in the education session before, because the industry was just beginning. Some doubted our abilities to meet all of the challenges associated with an emerging industry, but today the Michigan chestnut industry finds itself at the precipice of an extraordinary moment—the formation of a new agricultural industry. By “industry” we do not mean individual growers and their individual successes and failures, but by “industry” we mean the ability of the nation to look to Michigan and the Midwest as a location where high quality commercial chestnuts are continuously produced. It should be recognized that the chestnut growers’ marketing cooperative, Chestnut Growers, Incorporated, plays a pivotal role in this growing industry.

There is no doubt that there are unknowns and many questions still loom over the chestnut industry, however, none have been insurmountable, so far. **This is why we are asking a few professional growers to consider chestnut production as they look to diversify their orchards. We will help them become established, and guide them to manage their orchards, if they seek such help.** We are not looking for dozens of growers, but instead a few large orchards in proper locations, willing to plant high quality germplasm.

### Background

Chestnut (*Castanea* spp.) is one of the most popular nut-bearing trees growing throughout Eurasia. South Korea, China, Italy, and Turkey account for more than 70 percent of worldwide chestnut production. Chestnut farming and production today are increasing in Australia, New Zealand, Chile, and the United

States. Worldwide chestnut production was greater in 2000 than 1980; however, production since 1990 appears to have leveled. The first decade of the 21<sup>st</sup> century has been challenging for Italy, a major producer of chestnuts as it is under strict quarantine regulations for the Asian chestnut gall wasp (*Dryocosmus kuriphilus*) an insect pest that entered northern Italy in 2002 and rapidly spread throughout that and other European countries. In some cases, up to 80 percent of yield has been reduced in Italy by infestation with this insect.

In the United States, the number of chestnut orchards has rapidly increased since the 1980s in what could be seen as an attempt to capture a portion of the import market valued at \$10 million (2007 = 9 million imported pounds). In 2008, USDA Agricultural Census survey included chestnut for the first time. It should be noted that the data are incomplete but the picture is valuable. These data suggest that more than 1,100 farms in the United States are growing chestnuts for commercial marketing and the average farm is approximately 3 acres. In Michigan there are 154 farms and 813 acres planted to chestnut averaging 5.3 acres per farm. **Based on Ag Census data, Michigan has more growers than any state.** For total number of farms, Michigan, Pennsylvania, Oregon, Florida, California and Ohio represent the top 6 states in terms of grower number, and the Midwest is the largest region. In terms of farm acreage, Michigan (5.3), California (4.4), Missouri (4.3), Ohio (4.0), Iowa (3.8), Oregon (3.6), Florida (3.5), and New York (3.2) are the leaders.

The species profile that make up commercial chestnut orchards in various regions of the United States are primarily due to grower response to chestnut blight. Generally, growers in western states (a chestnut blight-free environment) plant blight-susceptible European chestnuts; and, eastern growers plant the naturally blight-resistant Chinese chestnut due to the continued presence of the blight pathogen in eastern states. Michigan is the only state where growers plant both Chinese and European chestnut species in orchards. Research in Michigan has demonstrated that European chestnuts produce 4 to 5 times more nuts and go into production sooner than Chinese chestnuts; however, with European-style chestnuts, Michigan growers must always monitor for chestnut blight.

Appropriate production practices, and careful harvesting are necessary to obtain good quality fresh chestnuts. Proper packaging, storage, and transport contribute to quality. Chestnut, as a seed and food, can remain alive long after harvest as the nut keeps respiring. Because of rapid respiration the chestnut can lose its freshness within a couple of weeks after harvest. Chestnuts contain a large amount of carbohydrates and water that facilitate microbial growth. Also, dehydration occurs rapidly if the chestnuts are not refrigerated. The use of best practices for postharvest handling, storage, and distribution of the fresh product is essential to preserve freshness. Management of relative humidity (90-95%) and low temperature (32-35 °F) are needed to extend the shelf life of this nut, and those can be achieved using an adequate packaging system.

This type of management cannot be done on the cheap. The cooperative concept has been instrumental in improving quality while saving money. For example, in countries like Australia, and the western states of the USA, every grower must invest in the same machinery, and post-harvest cleaning and storing equipment. With the grower cooperative concept, as in Michigan, the grower-members of the cooperative sell their harvested chestnuts to the cooperative and the cooperative manages the grading and storage.

### **Entrepreneurial Chestnut Growers**

Pioneering a novel agricultural industry is full of excitement and fraught with challenges. It took more than 50 years for the cherry industry to become established in Michigan and during the 1960s and 1970s. In California, the failure of many startup kiwi farms was the result of substandard plants, poor soil conditions, improper irrigation or planting site preparation, inadequate training, and a general lack of

knowledge concerning commercial culture. Finally, in the 1970s kiwi farms became highly productive with good management, more experience and more knowledge. The list goes on.

Before 1980, most chestnut farms were independent ventures established by members of state or national non-profit, hobby nut grower associations that supported members' efforts to grow tree nuts. In the early 1980s more chestnut farms appeared due to push by a particular chestnut group. In 1990, two highly respected MSU County Extension Directors, Jim Bardenhagen (Leelanau Co.) and Burt Stanley (Antrim Co.) held a meeting at MSU dealing with two fundamental questions that make up the foundation of MSU's long term interest in chestnuts today: "How does MSU want the Extension Service to respond to the planting of chestnut?" And, "What do we tell growers when they ask if they should plant chestnut?" Both directors were experts in cherries, apples and other fruit, but they knew little about chestnut—not many extension agents or researchers did at that time. MSU responded by holding public chestnut meetings and presenting a balance of speakers from different interest groups beginning the process of open meetings to educate everyone on practices that would benefit the struggling farms.

About that time (1996), I was asked to become an advisor to the non-profit Midwest Nut Producers Council (MNPC). This organization was established in 1987 to provide education and research for chestnut production in Michigan and other Great Lakes States. In 1992, the MNPC had initiated a chestnut cultivar trial at the MSU Southwest Research and Extension Center in Benton Harbor. By 1996, the data from the trial suggested 'Colossal', a EuropeanXJapanese hybrid from California produced large yields of large nuts, and studies with chefs disproved a long-held belief that the 'Colossal' nut had a poor taste. Beginning in 2001, members of the MNPC formed the for-profit chestnut grower cooperative Chestnut Growers, Inc., with 40 members primarily from Michigan, the Midwest and Washington State.

Today, prospective chestnut growers contemplating investment in a chestnut orchard can still find what they want on the Internet to support their decisions. Publications can have somewhat conflicting views. Oregon extension horticultural specialist R.L.Stebbins (retired) (1990; updated in 1997) states, "*At present there is no U.S. chestnut industry. Certain conditions must be met for the industry to develop to even modest levels of production.*" The prospective grower is just as likely to find a statement by California farm advisor Paul Vossen (2000), "*Should the domestic consumption level rise to only 1 pound per capita...such an industry could be worth \$600 million to \$800 million annually.*" Based on publication dates, and the state of the industry at the time, neither statement is necessarily wrong; however, in the past a clear message was never sent to potential growers. Today, we can say that there are no promises. Growers should be able to receive \$1.00 to \$2.00 a pound (more or less) for chestnuts. Some growers will tell you that they have made more and there is no reason to doubt this. However, those prices usually come from small boutique markets where grower/farms themselves (rather than the cooperative) have had to shoulder the storage, cleaning and grading. To market tons of chestnuts, the buyers generally want the largest, highest quality chestnuts and the prices are set at terminal ports as the chestnuts come from abroad. In an interesting reversal of fortunes, the domestic chestnut industry may be slowly eroding the European chestnut import market as buyers begin to discover that domestic chestnuts are just as large, just as tasty, and of higher quality than the imports.

Phil Tocco (Extension Educator, Preharvest and Postharvest Food Safety) studied chestnuts at markets selling both foreign and Michigan-grown chestnuts in Michigan. He found that Italian-grown chestnuts as compared to Michigan-grown chestnuts had almost twice as many rotted chestnuts per pound. So our quality is already better than foreign imports, but the size of our chestnuts did not measure up to Italian-grown chestnuts. Therefore, we must be concerned with growing cultivars that will provide the largest possible chestnuts. It will not take long for the market place to find that Michigan chestnuts are higher in quality, if not exactly the same size.

## **What Happens When Markets Become Saturated?**

Recently, this email was received from an Australian chestnut grower in 2011 (remember, their market is in April): *"We had a good year with production. Unfortunately, the rest of the industry in Australia also had a bumper year and there were also imports from New Zealand that flooded our markets. Subsequently, we received the lowest (and worst) prices ever from the wholesale markets."* Because of this common reality in today's world, in 2001, the MSU chestnut research team helped the MNPC write a USDA Rural Development grant to obtain a chestnut peeling line from Italy. It is the only commercial peeling line in the western hemisphere. They lease it to the growers cooperative, Chestnut Growers, Inc. The experimental peeling plant is housed at the MSU Rogers Reserve Endowed Research Farm in Jackson, MI. Several unique chestnut products have been discovered there including freeze-dried chestnut Slices™, oven-dried chestnut chips, and chestnut flour. These unique products were developed as a partnership between growers and the MSU chestnut research team.

## **Non-grafted (Seedling) Trees Have Hampered the Growth of the Michigan Industry**

The foundation to any agricultural industry is the germplasm you plant. Unfortunately, the chestnut germplasm planted in the 1980-90s was mostly inferior. They were non-cultivars, that is, not grafted, just wild Chinese chestnut. The orchards that emerged were more similar to Chinese chestnuts forests than predictable, productive orchards. The industry has had to overcome this early mistake. Please understand that for whatever reason, there are still people trying to sell you seedling trees (seedling = not grafted, it has nothing to do with age of tree). These trees are usually cheaper and will grow regardless of conditions, but they rarely go into production in Michigan. In other states, they will, but it will stay take many years. Professional growers will never fall for this ruse.

Once the EuropeanXJapanese chestnut cultivar 'Colossal' was discovered to have a high yielding, high quality chestnut, orchard fortunes started turning around. Today, a 5-year-old 'Colossal' chestnut tree should be producing about 5 pounds per tree and a 10-year-old 'Colossal' chestnut should be producing more than 20-50 pounds. In our variety in Benton Harbor, 'Colossal' was producing 80 pounds per tree. There should be about 20-30 nuts per pound. Anything smaller is harder to sell, except to smaller boutique markets.

Today, we really like a cultivar called 'Bouche de Betizac' ('BdB'). Another EuropeanXJapanese hybrid, this cultivar is thought to be chestnut blight resistant, Asian gall wasp resistant (in case the insect is ever found in Michigan) and an excellent producer of large nuts. The shift is away from 'Colossal' and toward 'BdB'. Also, another cultivar that is needed for pollination of 'Colossal' and 'BdB' is 'Precoce Migoule'. This tree is a great pollen producer and it produces good nuts.

Korean chestnut is a type of Japanese chestnut and we have a good one, 'Labor Day' (sometimes listed at J160) that can be planted with the EuropeanXJapanese hybrids. This tree in Clarksville has produced between 10-30 pounds within 10-years after planting.

If you want to grow Chinese chestnuts, it will take longer to get large yields and the nuts will be smaller. However, these trees are completely resistant to chestnut blight while the EuropeanXJapanese hybrids are not (other than 'BdB'). It may be more difficult to market the Chinese chestnuts, but once you have sold some and buyers have tasted them, they will soon discover the wonderful Chinese chestnut. Do not plant seedlings. Good cultivars adapted to Michigan conditions exist. Look for the cultivars 'Benton Harbor', 'Peach', and 'Everfresh'. The 'Dunstan Hybrid' is a seedling tree even though it has a name. This means it will grow similar to all seedling trees meaning it will be mostly variable in production and many trees will not produce anything for many years.

Growers need to be aware that deer browse, weeds, lack of irrigation in early years, sunscald, lack of fertilizer, inadequate or lack of pruning, and poor pest control have led to orchard failures. However, it has also been shown that, in Michigan, if you give the best of care to poor quality germplasm (like seedlings), the orchard will rarely amount to much.

### **A New and Important Discovery in 2011**

Due to our recent research findings we are no longer recommending planting of Chinese chestnuts in the same orchard as EuropeanXJapanese hybrids like ‘Colossal’, ‘Bouche de Betizac’, or ‘Precoce Migoule’, and other European hybrids that are available. Keep the pollen of Chinese chestnuts (seedlings or grafted trees) at least 500 feet away from the European trees. Do not interplant EuropeanXJapanese chestnuts with Chinese chestnuts. We have found that it is Chinese chestnut pollen that causes somewhere between 10 to 30 percent of the chestnuts to undergo a physiological kernel decay in EuropeanXJapanese chestnuts, like ‘Colossal’. This decay is not caused by a fungus, or by storage conditions, but the kernel simply decays on its own. We call this affliction internal kernel breakdown (IKB). The easiest thing to do when setting up new orchards is to keep the two species (Chinese and European/Japanese hybrids) far apart.

### **Pests**

In Europe and in other states, chestnuts are plagued with chestnut weevils, insects that lay eggs in the developing kernels. The larvae hatch and begin to eat the kernel and around harvest time, they emerge from the kernel as white “worms”. So far, we have not seen this pest in Michigan orchards. If it arrives, the chestnuts will need to be heat treated after harvest and before marketing. Japanese beetles, rose chaffers, and potato leaf hoppers need to be managed in the orchard. These pests will set back trees and even kill them. Insecticides are available for this. Scale and mites can be problems. Again, treatments are available. The Asian gall wasp is quarantined. Michigan cannot receive any chestnut plant parts (other than seed) from any state with gall wasp. If a nursery tries to sell you germplasm from a state with gall wasp, please inform the Michigan Department of Agriculture and Rural Development. MDA’s exterior state quarantine places restrictions on the movement of chestnut nursery stock from the following quarantined states - Alabama, Connecticut, Georgia, Kentucky Maryland, North Carolina, Ohio, Pennsylvania, Tennessee, and Virginia.

### **Summary**

Chestnut plantings are quickly becoming one way to diversify orchards in Michigan. If you are considering growing chestnuts, please attend MSU-sponsored meetings (usually with the Midwest Nut Producers Council in February or March). Not all chestnut meetings are sponsored by MSU. At these meetings, all aspects of chestnut orchards, cultivars, care and harvest are discussed at MSU-sponsored meetings. Researchers present recent findings. We have field plots that you may tour to back up our findings. Please feel free to go to the Rogers Reserve website ([www.RogersReserve.org](http://www.RogersReserve.org)) and click on the “Chestnut” menu. People from around the country call me to discuss what they have read on this website. It is a great place to get current information. Remember, there are good planting years, and bad planting years. Don’t plant all of your trees in one year. Grow your orchard as you grow your trees. Visit our booth (Rogers Reserve) here at the Great Lakes Expo to discuss the possibility of becoming a grower of chestnuts. Join the Midwest Nut Producers Council to help support education and research on chestnuts. Go into this with your eyes wide open. Ask questions, be skeptical of claims and remember this....the biggest problem with fruit and nut trees is the weather, and you can do little about that.

# **Can We Grow Tasty Chestnuts? A Descriptive Sensory Analysis of Chestnut Cultivars Grown in North America**

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Consumers purchase foods for a variety of reasons. Sometimes produce is purchased because of persuasive advertising, placement or the presentation of the commodity on shelves and in displays, visual characteristics of the product, packaging, or pricing. However, repeat purchases most often influenced by sensory characteristics such as appearance, aroma, flavor, and texture.

The primary human senses used to evaluate food are sight, hearing, touch, taste, and smell. Humans often use more than one of the senses to judge food and each sense may not be used independently. For example, nuts with dark-colored kernels are often perceived as having a stronger flavor than those with light-colored ones. Also, human senses can be fooled. For example, a red-colored drink with an orange flavor is often judged by consumers to be cherry-flavored.

Because consumers often lack experience in describing food, trained experts are often used to describe the sensory characteristics of foods. While some nuts, such as almonds and peanuts have extensive lists of descriptors, much less information is available on chestnuts. In Europe, chestnut sensory studies generally assess overall color, appearance, flavor, taste, texture and absence of pellicle intrusions. One Italian study also evaluated ease of chestnut peeling, aroma, firmness, sweet, salty and bitter attributes. Because different chestnut species and cultivars are grown and marketed in North America, a study was conducted to evaluate texture and flavor attributes of commonly grown chestnut cultivars using descriptive sensory analysis.

For this study, cultivar ‘Qing’, ‘Eaton’, ‘AU-Homestead’ and ‘Colossal’ chestnuts were harvested at the University of Missouri Horticulture and Agroforestry Research Center near New Franklin, Missouri. Marrone di Castel del Rio chestnuts were provided by a commercial grower in Isleton, California. Colossal chestnuts were also obtained from the same source in California and another producer in Owosso, Michigan to assess site variation. Immediately after harvest, chestnuts were washed, dried for 4 hours, sealed in polyethylene bags and stored at 40°F until sensory characteristics were evaluated by six highly trained panelists at the Kansas State University Sensory Analysis Center. Because panelists had limited experience with chestnuts, three orientation sessions were used to identify chestnut sensory attributes. Also, panelist’s understanding and the ability to use the identified sensory characteristics were carefully assessed during these orientation sessions.

After the preliminary sessions, panelists evaluated the samples in a room with natural and fluorescent lighting at 72 °F and 55 % relative humidity. Before serving, chestnuts were cured for 3 days at 72 °F. Nuts were scored and oven-roasted at 400°F for 25 minutes. Five chestnuts were then placed in styrofoam bowls and covered with a lid for 10 min before serving. Panelists were instructed to use at least three samples during evaluations. Distilled, deionized water and unsalted crackers were served as palate cleansers. Each of the attributes was evaluated using a 0 to 15 point intensity scale (0.0 = none to 15.0 = extreme). Eight samples were presented to the panelists during each session. All samples were evaluated in triplicate over six 1.5-hour sessions.

Twenty-three sensory attributes were identified to describe the chestnut cultivars in this study (Table 1). Chestnut cultivars were characterized by a slight nutty flavor (5.4 to 6.0 mean intensity ratings). Slightly lower impressions of brown, toasted and beany flavors were also perceived in chestnut samples (4.0 to 4.9 ratings). Lower, but detectable levels of hazelnut-like, almond-like, maple, buttery, caramelized, musty/dusty, musty/earthy, oily, sweet, sour, bitter and astringent flavors (< 3 ratings) were perceived. Mustard flavor was present at low sensory threshold ( $\geq 1$  rating) in only one sample and ratings for floral/fruity, raw impression and fermented were very low (< 1 rating). These results demonstrate that cultivars commonly grown in North America have a complex flavor profile.

Results from this study also indicated that six sensory characteristics of the chestnuts varied among cultivars (Table 2). 'AU-Homestead', 'Eaton' and 'Qing' chestnuts had higher peelability ratings than all other cultivars. These cultivars, in addition to 'Colossal' from Missouri and 'Peach', were also easier to peel than 'Colossal' harvested in California. Initial firmness ratings of 'Colossal' from Michigan and Missouri and 'Marrone di Castel del Rio' chestnuts were lower than all other cultivars. 'Marrone di Castel del Rio' chestnuts had a higher dissolvability rating than those of 'AU-Homestead', 'Colossal' from California, 'Peach' and 'Qing'.

Three flavor attributes differed significantly in intensity ratings among cultivars. 'Marrone di Castel del Rio' chestnuts had a higher mustard intensity rating than those of all other cultivars. 'Marrone di Castel del Rio' and 'Colossal' from Michigan chestnuts were sweeter than those of 'Peach' and 'Qing'. 'AU-Homestead' and 'Peach' chestnuts had a higher sour intensity rating than 'Colossal' chestnuts from Missouri.

The reason 'Colossal' chestnuts from California were distinguished from those grown in Michigan and Missouri may be attributed to extreme climatic conditions before harvest. In Isleton, California the mean maximum daily temperature in August (no precipitation) and September was 91°F (0.5 inches rainfall). In contrast, the mean maximum daily temperature where other 'Colossal' chestnuts were grown was 78 °F and 62°F in August and September, respectively, in Owosso, Michigan and 82°F and 76°F, respectively, in New Franklin, Missouri. Precipitation at both locations was over 2 inches for each month. Thus, high temperatures before harvest may have altered the development of flavors, resulting in relatively lower ratings of maple, brown, toasted, buttery, caramelized, and floral/fruity flavors for Colossal chestnuts from California as compared to those samples from the other two cooler locations.

The mustard flavor may be related to undetected microorganisms under the pericarp (shell) or within other tissue even though chestnuts with visible defects were discarded. In other studies, microorganisms have been isolated from the pericarp surface and cotyledons (edible "nut") of chestnuts. In a Michigan survey, several microorganisms negatively impacted fresh chestnuts. A post-harvest disinfectant treatment can be used for long-term storage of chestnuts. However, in this study, chestnuts were not disinfected to prevent the introduction of non-chestnut flavors.

While this study provides a sensory profile of various chestnut cultivars, it does not provide information on how well consumers like one particular cultivar as compared to others. This is a different type of experiment where untrained volunteers taste and rate how much they like the cultivar. This type of study is more difficult to conduct. For example, university surveys using human subjects must be approved by a review board and participant consent forms must be signed. Also, a small incentive, such as \$5 or a prize is often used to entice participation in the study. Also, a controlled environment for testing must be used, samples randomized, and data statistically analyzed. This type of study requires more fresh product, time and labor than the previous descriptive type, but can provide very useful information to producers and sellers. However, for further expansion and growth of the North American chestnut industry, it is imperative that this type of information is known.

Table 1. Descriptive terms and definitions used in the sensory analysis of chestnuts.

Attribute	Definition
<i>Tactile</i>	
Peelability	Ease of peeling the shell and pellicle away from the nut
<i>Texture</i>	
Initial firmness	Force required to initially bite through one piece of nutmeat using the incisors
Dissolvability	Degree to which the sample dissolves or remains semisolid when manipulated against the roof of the mouth with the tongue after 7 chews
<i>Flavor</i>	
Nutty	Intensity of all nutty characteristics including sweet, oily, light brown, slightly musty and/or buttery, earthy, woody, astringent and bitter flavors
Hazelnut-like	Sweet, light brown, oil somewhat woody aromatic associated with hazelnuts
Almond-like	Sweet cherry pit-like nutty aromatic associated with almonds
Maple	Sweet aromatic characterized as caramelized, woody and slightly green
Brown	Rich, full aromatic with a degree of darkness generally associated with canned pinto beans
Toasted	A brown, baked aromatic impression
Buttery	Aromatics commonly associated with natural, fresh, slightly salted butter
Caramelized	Aromatic of a round, full-bodied, medium brown sugar
Raw	An unprocessed or an uncooked impression
Beany	Slightly brown musty/earthy, musty/dusty, slightly nutty and starchy aromatics associated with beans
Fermented	Sweet, slightly brown, overripe aromatics associated with fermented fruits, vegetables, or grains with yeasty notes
Mustard	Sweet, woody sour, vinegar-like, somewhat pungent, slightly horseradish-like aromatics associated with prepared mustard
Floral/fruity	Aromatics associated with flowers and non-citrus fruits
Musty/dusty	Aromatic associated with dry, brown soil
Musty/earthy	Aromatics of a damp basement or soil or decaying vegetation
Oily	Light aromatics associated with vegetable oil such as corn or soybean oil
Sweet	Basic taste associated with sucrose
Sour	Basic taste associated with citric acid
Bitter	Basic taste described as harsh with the taste simulated by solutions of caffeine
Astringent	Sensation of drying, drawing-up or puckering of any of the mouth surfaces

Table 2. Mean sensory attribute intensity ratings for chestnut cultivars.

Descriptor	‘AU Homestead’	‘Colossal’ California	‘Colossal’ Michigan	‘Colossal’ Missouri	‘Eaton’	‘Marrone di Castel del Rio’	‘Peach’	‘Qing’
Peelability	14.86 <sup>a</sup>	8.08 <sup>d</sup>	9.36 <sup>cd</sup>	11.67 <sup>b</sup>	14.83 <sup>a</sup>	8.72 <sup>cd</sup>	10.28 <sup>bc</sup>	14.83 <sup>a</sup>
Initial firmness	7.00 <sup>a</sup>	6.86 <sup>a</sup>	5.81 <sup>b</sup>	5.94 <sup>b</sup>	7.33 <sup>a</sup>	5.86 <sup>b</sup>	7.08 <sup>a</sup>	7.06 <sup>a</sup>
Dissolvability	6.50 <sup>bc</sup>	6.39 <sup>c</sup>	6.97 <sup>ab</sup>	6.75 <sup>abc</sup>	6.81 <sup>abc</sup>	7.08 <sup>a</sup>	6.36 <sup>c</sup>	6.44 <sup>c</sup>
Nutty	5.75	5.78	5.92	6.03	5.72	5.58	5.42	5.58
Hazelnut-like	1.92	1.94	2.19	2.06	2.06	1.61	1.69	1.94
Almond-like	1.94	1.81	1.86	2.06	1.92	1.92	1.47	1.78
Maple	1.61	1.78	1.94	1.92	1.72	1.50	1.50	1.56
Brown	4.78	4.42	4.72	4.89	4.86	4.69	3.97	4.25
Toasted	4.33	4.17	4.50	4.61	4.50	4.39	3.94	4.19
Buttery	2.72	2.56	2.78	2.94	2.72	2.92	2.47	2.75
Caramelized	2.36	2.53	2.72	3.14	3.17	2.42	2.11	2.72
Raw impression	0.28	0.47	ND	0.06	0.17	0.11	0.61	0.58
Beany	4.39	4.11	4.31	4.28	4.31	4.22	4.31	4.67
Fermented	ND	0.14	ND	ND	0.25	ND	0.11	0.06
Mustard	0.17 <sup>b</sup>	0.33 <sup>b</sup>	0.33 <sup>b</sup>	0.58 <sup>b</sup>	0.17 <sup>b</sup>	1.58 <sup>a</sup>	0.11 <sup>b</sup>	0.31 <sup>b</sup>
Floral/fruity	0.44	0.39	0.61	0.67	0.64	0.44	0.33	0.33
Musty/dusty	2.44	2.56	2.28	2.36	2.47	2.36	2.47	2.31
Musty/earthy	1.89	2.19	2.00	2.17	2.28	2.22	2.39	2.36
Oily	2.64	2.53	2.69	2.69	2.53	2.72	2.39	2.47
Sweet	2.50 <sup>bcd</sup>	2.64 <sup>abcd</sup>	2.78 <sup>ab</sup>	2.67 <sup>abc</sup>	2.69 <sup>abc</sup>	2.92 <sup>a</sup>	2.36 <sup>d</sup>	2.44 <sup>cd</sup>
Sour	1.92 <sup>ab</sup>	1.72 <sup>bc</sup>	1.72 <sup>bc</sup>	1.64 <sup>c</sup>	1.72 <sup>bc</sup>	1.78 <sup>bc</sup>	2.00 <sup>a</sup>	1.78 <sup>bc</sup>
Bitter	2.39	2.44	2.19	2.42	2.31	2.25	2.89	2.42
Astringent	1.75	1.75	1.75	1.86	1.81	1.89	1.92	1.86

Values with different letters in a row are statistically significant at  $P \leq 0.05$  by Fisher’s least significant difference (LSD) test. ND (not detected).

# Commercial and Research Opportunities for Chestnut Harvest

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How many questions should a chestnut grower be asking before deciding on a machine for mechanical harvesting? Answer: MANY!

As trees of cultivated chestnut orchards begin to reach significant production levels, as is the case with many orchards in the emergent Michigan chestnut industry, the issues of harvest rise to the top as a priority. The Michigan chestnut production is advancing from being a hobby to becoming a legitimate commodity industry where critical business decisions should be studied.

## Constraints

Because chestnuts are not physiologically mature until they are released from their enclosing bur, which basically means when they drop, the harvest, short of having a catching frame under each tree, is restricted to ground pick-up. Shaking will tend to bring down immature chestnuts which result in quality and peeling issues (a whole other topic!). Gathering chestnuts from the ground obviously results in the likelihood of interference and interacting with materials and contaminants on the ground which adds challenges and requirements.

## Considerations in harvest method selection (i.e. What questions should be asked!)

There are both obvious and unexpected inputs into the decision equation when working toward selection of harvesting equipment for chestnuts. Below is an extensive, but not necessarily exclusive, list of such aspects to consider:

- 1) What is my orchard size, but more importantly, at the peak of harvest, how many pounds per hour (capacity) must I be able to harvest?
  - a) The highest quality chestnuts do not sit on the ground more than 2 days and are quickly put under cold storage. Thus, at the peak of harvest you should be able to harvest half of your orchard every day. This also minimizes your loss to wildlife.
  - b) How many hours are available for harvest each day?
- 2) Do major slopes exist in my orchards (as some machines do not operate safely or as effectively on slopes)?
- 3) What is the final market for my chestnuts (mechanically harvested nuts will not be quite as pristine as hand harvested nuts, however, after storage time this difference is seen to lessen)?
- 4) Human ergonomics: Some methods require one to carry/drag a large flexible hose around the orchard and bend over slightly)

- 5) Am I willing to eliminate branches or establish an orchard resulting in no low hanging limbs?
- 6) VERY IMPORTANTLY, ground preparation and ground cover. Some harvesting methods are more sensitive to this than others. Self propelled sweeping machines are most ideally suited for firm, flat, smooth, and debris free (no excess living or cut grass and no limb pieces) ground conditions.
- 7) Economics of mechanical harvest versus hand harvest (\$0.30 to \$0.50/lb) and labor availability for a given size orchard.

### **Harvest Concepts/Options**

The following are modes or concepts of harvest. The most feasible or most appropriate method for any given operation is governed by the results of the questions and thoughts above. The systems are generally listed in increasing order of complexity and cost.

- 1) Hand harvest (some pick-up tools/assists available such as Nut Wizard ([www.nutwizard.com](http://www.nutwizard.com))). Limited by labor availability and ability to collect chestnuts in a timely fashion. Laborer must do in-field sorting/selection. Some sensitivity to ground cover.
- 2) Sweep (everything) in orchard with off-line secondary cleaning. Less expensive means of self-propelled harvest and relatively fast, but requires second process of separation/cleaning. Does remove debris from orchards so it is not run through harvester multiple times. Requires relatively smooth ground surface.
- 3) Vacuum (hose or otherwise), pick up everything, secondary cleaning. Somewhat restricted to smaller producers due to capacity of pick up and transport of nuts plus debris/burs.
- 4) Vacuum hose, all-area coverage, with on-board air and physical sieve sorting. Labor required to drag hose and vacuum most all material from under/around the tree. Debris is discarded. Can be PTO driven (trailer or 3-point hitch) or self powered units. Intermediate in cost.
- 5) Vacuum hose, following windrowing, with on-board sorting. Increases efficiency of pick up process and is more ergonomically friendly to laborers. Requires separate machines for windrowing and pick up.
- 6) Sweep/vacuum combination, self propelled, on-board cleaning/separation, bagging. One machine does all. Various sized/capacity machines to match to production. Requires good orchard management in pruning and ground surface preparation. Single operator or with bagging assistance labor.
- 7) Sweep/vacuum combination, self propelled, on-board cleaning/separation, with receiving trailer. Same as #6 above but chestnuts are collected into box trailer and only single operator is required.

### **Commercial Machines**

Most commercial chestnut harvesting machines have been developed in, and are sold in, Europe. The question remains whether these companies will open up sales to the U.S. either directly, or most likely through a distributor. The machines have been developed and refined over many years and have some unique and effective components and appear to operate well when the orchard is managed in consideration of the harvester. Below is a non exclusive list of some companies involved in chestnut harvesting machines. Most companies have a range of systems covering some of the concepts and options above.

FACMA: [www.facma.eu](http://www.facma.eu) (Italy) Self propelled sweep/vacuum units ranging in capacity from 500 – 1700 kg/hr. Trailered PTO powered hose vacuum units ranging in capacity from 200 -900 kg/hr. Windrowers.

Monchiero: [www.monchiero.com](http://www.monchiero.com) (Italy) Self propelled sweeping units and also PTO driven trailered hose vacuum units.

Chianchia: [www.chianchia.it](http://www.chianchia.it) (Italy) 3-point hitch mounted hose vacuum units and various small scale electric powered cleaning stations and accessories.

Jolly: [www.gf-srl.it](http://www.gf-srl.it) (Italy) 3-point hitch mounted mechanical sweeping and cleaning unit.

As noted, this is not an exclusive list. Additionally, the question might arise as to the potential to use harvesting machines from other nut commodities such as almonds or pecans, etc. In principle or concept some of these systems could be used, however, in those situations the nut is basically the largest object being picked up which tends to simplify the system. Limited understanding of these machines lead the author of this document to suggest modifications necessary to adapt such related crop harvesters and the inefficiencies that would remain would outweigh advantages of working with them as a system that already exists in the U.S.

### Research and Development

Michigan State University (MSU) has been involved with looking at harvest opportunities for the growing Michigan chestnut industry. Some rough economic analysis has led to the suggestion that a void in harvesting equipment exists for “small” growers (2-8) acres who have no or minimal labor force (see figure 1), however, at this time not all commercially available systems have been observed. Our present observation is that growers with less than 2 acres can find enough local labor to conduct harvest and mechanization is likely not economically practical, while growers with greater than 8 acres should probably look at the likelihood that existing commercial systems, even though they are made in Europe, may likely be an economically feasible option. Additionally, it appears, at least for the time being, that a US manufactured system would have multiple advantages (availability, cost, repair, etc.)

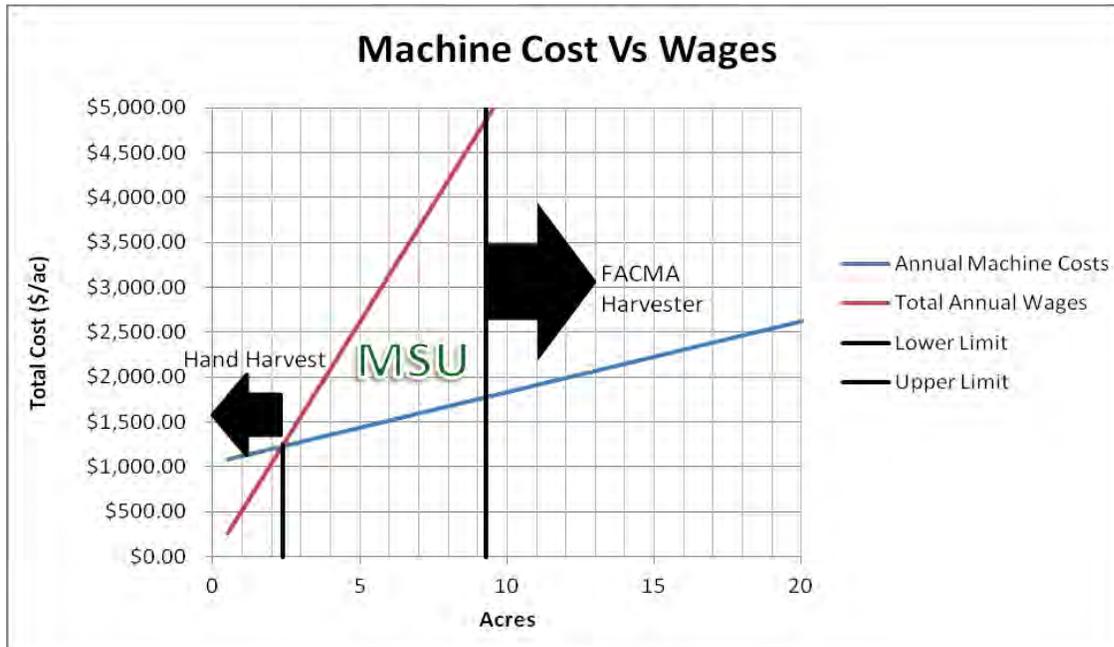


Figure 1. Approximate harvest cost economics for hand versus machine harvest for \$7000 machine and 3000 lb/acre production.

With this in mind, the MSU chestnut team has had conversation with the chestnut industry as to what they would currently like to see as priority in a newly/uniquely developed system. In other words should the system simply pick up everything for later cleaning; or should the system do “some” cleaning but doesn’t need to be perfect; or should the system harvest and conduct a clean sort? Clearly increased capability and capacity come at a cost. MSU has decided to attempt to maximize capability and minimize cost through development of a new concept which involves a single-stage combined vacuum and separation system involving simplicity and minimal mechanisms/components (see fig 2). Initial tests have shown the concept to have potential.



Figure 2: Single-stage chestnut harvester development prototype.

Positive aspects: Picks up and separates desirable and undesirable material; it is additionally very easy on the chestnuts. System is expected to be simple and small, possibly pulled by a small ATV or utility vehicle or mounted on a 3-point hitch.

Negative aspects: The concept/system incorporates the requirement of the need to use large vacuum hoses (as with many commercial systems).

Questions remaining: Can the components be better optimized? Does a short line manufacturer exist to move it to a commercially available system? What would be the cost of the system and can it be a feasible option?

It should be noted that some systems with similar capabilities as those being addressed by the new MSU concept, and that might have potential cost effectiveness, are commercially available from the European manufacturers with an approximate cost of purchase and delivery of around \$13,000.

### **Additional Research**

MSU has acquired a FACMA self propelled chestnut harvester. The purpose of this acquisition is to conduct research on the capabilities of the machine and gain an understanding if the unit can function under existing or modified U.S. conditions. The unit was acquired such that it can be used in self

propelled mode or as a simulated vacuum hose system so MSU and growers can conduct tests, demonstrations, and evaluations on efficiency, ground covers, and ergonomics. MSU is additionally conducting tests on nut quality between mechanically and hand harvested chestnuts.

### **Summary**

Commercial harvester options exist and many questions related to economic feasibility, ergonomics, orchard size and production, and willingness to conduct proper orchard management for specific harvester types need to be considered before making a harvester purchase. MSU is positioned to help growers with these questions. Clearly with increased capability and capacity comes increased cost. MSU feels a void possibly exists in an ideal harvester for many of Michigan's chestnut producers and is working on development of a potentially unique and cost effective system for small producers.

### **Disclaimer**

Michigan State University does not endorse any manufacturer or type of system at this time. MSU is positioned to assist producers in understanding the operation of as well as the advantages and disadvantages of harvesting system types.

## **CHESTNUT GROWERS, INC.**

### **A Marketing Co-Operative in the State of Michigan**

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Chestnut Growers, Inc. is a business corporation organized as a cooperative to serve the needs of its member patrons rather than to make a profit on its own. A cooperative is distinguished from other businesses in that it is service-driven, rather than profit-driven. The goal of the cooperative is to provide its members with services and goods that would be economically impossible for members to obtain individually.

Chestnut Growers, Inc. established a corporation as a co-operative in 2002. CGI is a producer owned and controlled processing and marketing cooperative with 38 grower members who joined the cooperative to access markets for unique and value added processed chestnut products. Members are located throughout the Lower Peninsula of Michigan and the state of Washington. Its product lines include fresh chestnuts, peeled and frozen chestnuts, dehydrated freeze dried sliced chestnuts, chestnut flour, and oven dried chestnut chips. The purpose of the cooperative is to provide the grower members with a place that will convert their chestnuts into products that can be sold at greater values than they normally receive through their individual sales and marketing efforts.

This co-op initially formed a steering committee in 2001 and started the process to form a legal corporation in the state of Michigan. The steering committee worked with advisors from Michigan State University and an attorney specializing in forming a corporation. The committee completed a feasibility study and started the business planning process providing a design on how the cooperative should run. The steering committee comprised of chestnut growers established guidelines for the resources necessary to make the venture successful. It has taken Chestnut Growers, Inc. a considerable amount of time and effort to establish the co-operative. The members have had to be very attentive to paperwork, accounting, administration, and legal issues. The co-op has learned about improving operations, advertising, and packaging. Since the co-op members own the business, they have been actively involved in seeking out markets and shoring up existing ones.

The company enjoys a competitive edge in the marketplace because it has access to the only commercial chestnut peeler in North America, access to a professional team of researchers at Michigan State University to develop new products, established relationships with local marketers of gourmet food products, and access to local markets to capitalize on current consumer interest in locally produced food products.

Its products appeal to ethnic markets, upscale innovators and health conscious consumers (especially consumers with celiac disease – intolerance of products containing gluten) as chestnut flour is gluten free. CGI has focused on its marketing efforts on food service and retail distribution channels. Its foodservice

marketing plan includes a relationship with a distributor of gourmet foods appealing mainly to professional chefs throughout the country. The cooperative's retail distribution is local in the Great Lakes Basin with distribution handled mainly by the members. The company maintains a website and toll-free telephone number through which it receives orders directly from foodservice and retail consumers. These orders are either delivered directly if locally based or shipped via an expeditor such as USPS, UPS, or FedEx. Fresh chestnuts are sold in a number of local venues directly to retail consumers or wholesale through existing retail outlets. The company has a sales and marketing presence at the Eastern Market in Detroit, Michigan.

The company uses promotional and public relations efforts to encourage customers who are not familiar with chestnuts and chestnut products to sample them. The primary promotional efforts focus on the holiday season surrounding Thanksgiving through Christmas by conducting chestnut roasting, sampling, selling at various festivals, and attending specific food shows to demonstrate chestnut products.

The cooperative is capitalized through its members who purchase stock to obtain the right to deliver raw chestnuts that can be converted to value added products at facilities that are accessible to the cooperative. Since it does not own any major capital equipment, its capital needs are limited to working capital for supplies related to packaging and selling its products, and marketing costs.

#### **Long Term Goals for Chestnut Growers, Inc.**

1. Create a profitable, sustainable business to process and market chestnuts for the members of the Cooperative.
2. Identify and market value-added products from chestnuts produced from the members of the cooperative.
3. Find niche markets for specialty value added chestnut products.
4. Find distribution channels for our chestnuts and chestnut products.
5. Increase the agricultural production of high quality chestnuts from our grower/members.
6. Increase the production and consumption of American grown chestnut and value added chestnut products in the United States.

The distribution strategy varies with the type of chestnut product CGI sells. The fresh in-shell chestnut is distributed by direct shipment from our storage facilities to our customers. Large orders (500# or more) are delivered by truck and smaller orders are shipped via UPS or USPS. CGI ships regionally throughout the Midwest. The chestnut product is kept fresh in CGI coolers and shipped directly from them. In Lower Michigan, CGI chestnuts arrive fresh the following day. In the Midwest, chestnuts arrive usually within three days. The cooperative has an 800 number and web site with shopping cart; orders are taken and shipped directly to our customers. CGI strives to get their chestnut product to our target customers as efficiently as possible.

CGI's fresh peeled-frozen vacuumed packed chestnuts are marketed through a selective distribution plan. The cooperative markets and distributes the peeled frozen chestnuts mainly through several upscale distributors of high-end gourmet foods. We transport directly from our freezers to our distributor's freezers. Our distributor markets and distributes our peeled frozen product through their market channels. Chestnut Growers, Inc. has an 800 number and web site to take orders and ships the product to customers.

The cooperative has a relatively new chestnut product called freeze-dried chestnut slices. This product is thinly sliced chestnuts that are dehydrated. This process enables Chestnut Slices to a very long shelf life. The Slices retain their buttery yellow color and rich sweet flavor. This chestnut product can be added directly to recipes and cooks very quickly. Chestnut Slices are delicious eaten right out of the bag and make a terrific snack. Freeze-dried chestnut slices are marketed in 2 oz., 4 oz., 8 oz., 16 oz., and 5 pound

resealable clear poly bags. This product is now shelf stable for at least two years without having to refrigerate and can be shipped without worry of spoiling. CGI can ship this product nationwide via USPS or UPS. Orders can be made through the web site or our 800 phone number. Currently, we have a distributor that markets the freeze-dried chestnut product to restaurants and chefs through its customer base.

Two other specialized products are being made and sold on our website. Chestnut flour is made by a couple of our growers and then sold as a CGI product. Chestnut flour is an alternative to wheat flour. It has a natural sweetness, which enhances the delicate flavors of many baked goods. Chestnut flour is one of the secrets of fine French pastries. For those who have an allergy (celiac disease) to the gluten in wheat flour, chestnut flour is a great substitute. CGI markets flour in half pound, 1 pound, 5 pound, 10 pound, and 25 pound bags. CGI offers instructions and information on the use and storage of chestnut flour. Also, another product recently developed is a oven-dried chestnut chip which we have found a niche market for making chestnut beer. A local microbrewery has used the oven-dried chestnuts chips to create a special chestnut beer that has a unique appeal in the market place.

CGI's website offers year round exposure to and promotion of our chestnut products. The cooperative has banners and a number of printed handout materials including excellent tri-fold handouts on chestnut products. The handout contains information and directions on the use of various products. We also have recipe handouts. We have a large chestnut roaster to use at various public events. We use direct mail to communicate with our past and future customers to urge them to order and use our chestnut products. Our website has recipes, chestnut product information, and events where the cooperative will be offering these items. The website has an easy access to buying chestnut products on the internet. Also, we have an 800 number to call for all customers with questions concerning chestnuts and ordering chestnuts.

Chestnut Growers, Inc. continues to gain a competitive advantage in the marketplace through networking, grants, and chestnut education to consumers. CGI has been cultivating its close working relationship with the Midwest Nut Producers Council (MNPC) through the last ten years. MNPC is a non-profit, public service organization with a primary objective of supporting chestnut industry promotion, education and research. MNPC has acquired a *brulage* chestnut peeler that Chestnut Growers, Inc. leases in order to produce its peeled chestnut products. The Midwest Nut Producers Council is a key partner in promoting the use of chestnuts and chestnut products with the consuming public. Since most of the members of MNPC are also members of CGI and this close working relationship is expected to continue into the future.

CGI is benefitting from a valued ongoing relationship with researchers at Michigan State University (including the MSU Product Center for Agricultural and Natural Resources) who are providing novel resources needed in testing new chestnut product concepts and consumer acceptance of new chestnut products. CGI was able to procure a grant with the Michigan Department of Agriculture to develop the Freeze-dried Chestnut Slices in 2008 via our relationship with the researchers at Michigan State University. We continue to work together on the developing chestnut industry and have other grants being worked on to further chestnut research with Michigan State University.

The recognition of CGI as a corporation in the State of Michigan has helped in selling chestnut products to major companies such as Whole Foods, Sysco, Meijer, and other major food companies. CGI is maintaining a focus on local markets to capitalize on the increasing consumer and foodservice trend to utilize locally grown, produced, and sustainable chestnut products.

Chestnut Growers, Inc. continues to strive for high quality chestnut products and customer service by improving the production practices of CGI members. We are upgrading our storage and transportation techniques for raw chestnut products and seeking constant improvement in our knowledge about processing chestnut products.

## Summary

In summary, Chestnut Growers, Inc. has been in business for over ten years. As a company, we have survived the inevitable time frame of lasting more than 5 years. As each year goes by, we have grown the cooperative and grown the revenue for the grower members. CGI is focused on creating a profitable, sustainable business to process and market chestnuts for the members of the cooperative. The co-op will continue to identify and market value added products from chestnuts produced from the members of the cooperative. We will find niche markets for specialty value added chestnuts and chestnut products (chestnut beer). Our member growers will find distribution channels for our chestnut products. The grower members will need to strive to increase agriculture production of high quality chestnuts and will need to continue to work with our Michigan State University partners to improve this production through research. As a grower-member-owned cooperative, the ability of its members to maintain profitable and sustainable businesses is important so they can provide quality raw chestnut product and meet the capital needs of the business.



Roger Blackwell sells CGI grower/member chestnuts at 3:00 am to a buyer at the Detroit Produce Terminal a couple days before Thanksgiving. The 1,000 pound pallet of large size chestnuts fetched a good price that morning.