Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Development
Agricultural Development & Diversification Program (ADD)
Grant Project Final Report

Contract Number: 23056

Grant Project Title: **Development of cut and peel carrot production systems for Wisconsin**

Amount of Funding Awarded: $22,500

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Proposal Concept Statement

Wisconsin farmers have a history of growing carrot with over 4,000 acres produced for processing in 2007. Wisconsin carrot farmers used to market a fair volume of raw product as fresh carrots in cello-pack. Changes in consumer preference led to primary sales of fresh market carrots as pre-processed, packaged, product sold as cut and peel or baby carrots. Over 95% of the U.S. cut and peel carrots are grown and processed in California and Washington. The transportation and distribution costs for fresh produce from the West Coast to Midwest and Eastern states could give Wisconsin carrot growers a distinct price advantage if quality raw product can be supplied for extended market seasons. The goal of this project is to determine production and storage potential for cut and peel carrot in Wisconsin. Processing carrot were worth a little more than $1,300/a whereas cut and peel carrot were worth an estimate $6,500/a in 2006 (National Agricultural Statistics Service, 2006)

Proposal Background and Description of Market Opportunity

There are several commercial carrot farms in Wisconsin that ranked third in the U.S. in total production during 2006. Wisconsin carrot production by these commercial farms totaled approximately 4,000 acres with farm gate value estimated at over $1,300/acre or $5.2 million each year. Carrot is a relatively high value vegetable crop that requires intensive management. Subsequently, carrot producers typically hire multiple employees for management and harvest of the crop. Carrot is produced on irrigated muck and sand soils in Adams, Brown, Columbia, Green Lake, Jefferson, Marquette, Oconto, Waushara and other counties. The profitability of carrot relative to other vegetables and commodity crops make it an important rotation crop for potato and onion growers across the state. However, the recent increases in grain and contracted vegetable prices have reduced the relative value of carrot.

All commercial carrot production in Wisconsin is contracted and targeted for processing into frozen or canned product. Processing adds value to the economic impact of carrot production to the state. Carrot is processed by Del Monte, Seneca, Lakeside and Bird's Eye in plants at Plover, Janesville, Manitowoc, and Beaver Dam Wisconsin. Carrot types grown for processing include slicing and dicing types that are used for multiple processed end products.

In addition to processing, carrots were grown for fresh market in Wisconsin up until the 1990's. Fresh carrots were packaged in cellophane as a washed product that required peeling and preparation prior to eating. Consumer demand for fresh carrots has changed dramatically over the past 10 to 15 years with most fresh market carrots being purchased as cut and peel. Cut and peel or 'baby' carrots are pre-prepared by peeling, washing, and packing as a ready to eat product. Primary difference between pre-prepared and processed is that processed carrots are cooked whereas pre-prepared carrots are raw. The demand for cut and peel carrots has nearly eliminated the market for cello pack carrots and resulted in total loss of the fresh market carrot industry in Wisconsin.

Cut and peel carrot production is concentrated in California and Washington which provides 95% of the North American supply. The increased cost of shipping carrot from the West Coast to Midwestern and Eastern United States has increased point of purchase prices by 5 to 10 cents per pound over the past 12 to 18 months. Wisconsin's proximity to Midwestern and Eastern U.S. with respect California and Washington may provide a distinct price advantage for the states carrot farmers. The estimated raw product value of cut and peel carrots is 4 to 6 fold that of processing carrots or up to $6,500/acre. Establishment of a cut and peel end market for Wisconsin carrots would likely have little impact on processed carrots, but rather increase the total carrot production acreage in the state.

In order to capitalize on the price advantage of being closer to end markets, Wisconsin carrot growers must be able to produce an end product with quality that is at least comparable to current products on the market. Key quality characteristics include size, shape, and flavor. Cut and peel carrots are typically 1.5 to 2.5" in length and between ¼ and 5/8" in diameter. To prepare carrots of this size growers typically produce carrot roots that are 8 to 12" long and no more than 3/4" in diameter. The carrots are then cut to length and peeled to produce an end product that is ideal for packaging as a baby carrot. These carrots must also grow strait in order to maximize recovery. Phil Simon in the Horticulture Department at the University of Wisconsin-Madison has been evaluating multiple carrot varieties and genotypes for there potential quality as a cut and peel carrot. Paul Miller, carrot grower, from Hancock Wisconsin has developed agronomic practices such as planting population, tillage, cover cropping, fertility management, and other practices necessary to produce carrot roots suitable for production of cut and peel product.

Largest quality question faced by Wisconsin growers is flavor of carrots. Phil Simon has documented the effects of climatic conditions on flavor characteristics of carrot. Under cooler conditions where carrot roots grow slower, carrots tend to have sweeter flavors. When conditions are warmer, carrot flavor is not as sweet as tocopherols become more prevalent. Simon also demonstrated that soil types can also influence carrot flavor, with carrots produced on muck soils tasting less sweet during hot conditions than on sand soils. Flavors also vary widely across carrot genotypes and some varieties can be grown during warmer conditions, but still produce a good tasting carrot. A key research need is to characterize changes in carrot flavor when planted at different times during the growing season and thereby subjected to different growing conditions.

Another important aspect for developing a successful cut and peel carrot system is the need to supply raw product for an extended portion of the growing season. Ideally, raw product that is available for 12 months allows for continuous production of carrot and prevents any interruption in supply. This is critical for identifying and maintaining continuous market relationships with grocery chains and retailers. Wisconsin growing season is suitable for providing supply of raw product for 6 months from July through December. However, research in the Potato and Vegetable Storage Research Facility at the Hancock Agricultural Research Station has indicated it may be possible to store processing carrots until at least March or April with minimal losses. Carrots grown for cut and peel that were stored until at least April would provide raw product supply for 9 months. This would minimize duration of time carrots would have to be imported to maintain finished product supply to grocers and retailers.

Carrots must be stored at conditions that minimize water loss to maintain crisp and crunchy texture necessary for cut and peel market. In order to minimize water loss, carrot respiration and evaporation of water from carrot must be minimized. Carrots are typically stored at 32 to 33 F to minimize carrot respiration while preventing freezing damage. Freezing leads to destruction of cells which results in soft carrots. Furthermore, carrots must be stored at 99% humidity to minimize evaporation of water from carrot tissue. Cold temperatures combined with high humidity results in condensation of liquids on surfaces in the storage including carrot. The free water on carrot promotes development of white mold and rotting of carrots. Near freezing conditions help delay development of white mold. Removal of all tops and washing of soil from carrot roots reduces white mold inocculum surrounding stored carrots which can also extend the storage season. However, even with these practices storing carrot beyond March or April has been difficult in processed carrots due to white mold development. Little data exists on extended storage of cut and peel carrots in Wisconsin. Important differences between cut and peel and processing carrots includes: 1) differences in varieties and likely differences in storability, 2) smaller carrot roots and subsequent increase in carrot surface area which will increase evaporative surface, and 3) better control of carrot pulp temperature. A successful cut and peel carrot system will require establishment of successful storage protocols to extend the supply for a longer marketing season.

Creation of a new agricultural product such as cut and peel carrot will require development of marketing plan. A number of potato packing sheds already have established market relationships with grocers and retailers across the Midwest and Eastern U.S. We propose to work with the Wisconsin Potato and Vegetable Growers Association Promotions Committee to identify packing sheds that are interested in evaluating wholesale marketing potential of cut and peel carrots from Wisconsin. Several managers of Wisconsin potato packing sheds have already been surveyed to determine the relative interest in marketing cut and peel carrots. Several packing sheds expressed interest in investigating the market opportunity that exists, although one manager strongly suggested that carrot flavor be acceptable to improve chances for success (see above). Based on these initial responses, we feel it is imperative that we investigate the possibility of producing cut and peel carrots in Wisconsin. We are proposing to fund development of a marketing plan through separate funding (i.e USDA Value Added Producer Grant).

Profitability, cost-benefit and risk analysis will be just as important as development of a marketing plan for cut and peel carrots. Increasing fuel costs and growing demand for interstate trucking has certainly increased point of purchase price and thus potential return to Wisconsin based cut and peel carrot producer. However, corn, soybean, wheat, and processed vegetable contracts for sweet corn, pea, snap bean, and carrot have doubled or tripled in the past 24 months depending on the crop. As a result, many crops may be price competitive compared to cut and peel with less risk. As such, cost benefit analysis must be completed on cut and peel systems and profit potential compared to established suppliers in Washington and California. The cost of growing cut and peel carrots must be compared to cost of importing finished product to Wisconsin and targeted end markets.

Finally, no facility is available in Wisconsin for cutting, peeling (pre-preparing), washing, and packaging carrot. A vendor resides in Wisconsin that currently constructs waterless cut and peel equipment. These machines are currently being used in carrot facilities in Western U.S. and Ontario Canada. Vendor has offered to negotiate availability of processing facilities within the region for evaluation of commercial scale samples (truck loads) of cut and peel carrots. In addition, multiple vendors are established in Wisconsin that sell and service packaging lines, packaging materials, and labeling materials to assist in preparation of end products. Separate funding will be used to create construction plan for processing facility, identification of proper permits, Health Approved Safety Standards Protection (HASSP) certification, tracking technology, and establishment of Good Agricultural Practices and Good Handling Practices. In addition, models for owning and operating the pre-preparing and packing facilities will be investigated including: 1) establishment of grower cooperative, 2) carrot grower investment in expansion and equipment procurement for existing packing facility, or 3) investment and expansion by single packing shed and contracting cut and peel carrot raw supply. Derivation of value added products from pre-preparing wastes must also be established.

The opportunity for establishing a cut and peel carrot industry in Wisconsin has been discussed amongst carrot growers and potato and vegetable packing sheds for several years. Key informational needs have been identified that must be addressed to determine feasibility of marketing cut and peel carrots from Wisconsin and establishment of raw product supply necessary to ensure year round availability of excellent quality end product. Successful establishment could result in increased carrot acres at increased value of 6,500/a (more than $1 million per 150 acres). Total fresh market carrot acres produced in the U.S. is over 80,000 acres and another 30% of fresh carrots are imported from Canada and Mexico. In addition, value added markets such as locally or regionally produced or organic carrots could be investigated developed in the future

Project Objectives and Accomplishments (This is first year of 2 year project)
The goal of this project is to develop a cut and peel carrot industry in Wisconsin. Meeting this goal will require establishment of marketing and business plan, preparing and packaging facility, and production and storage management protocols that insures continuous supply of high quality crop. Separate funding is being requested from the USDA Value Added Producer Grant program to conduct the marketing and business plan and the preparing and packing infrastructure. We are requesting funding to conduct research necessary for development production and storage management protocols.

1) Determine carrot flavor constituents when planted at different times during the growing season and harvested for cut and peel.

2) Quantify moisture loss, shrink, white mold development, and quality of cut and peel carrot when stored for up to 8 months.
3) Determine recovery of commercial scale cut and peel carrot samples from the field and from storage.

Objective 1) Determine carrot flavor constituents when planted at different times during the growing season and harvested for cut and peel.
Field research trials are being conducted in collaboration with carrot growers on irrigated sand soils near the Hancock Agricultural Research Station and on a muck carrot farm. Common research protocols were implemented at each research site. Whole plot factor was planting date with treatments including April, May, and June. Initial plans were to include a July, August, and September planting dates, but crop maturation would not have been possible. Carrot requires 90 days to reach suitable size for harvest as cut and peel. Sub-plot factors were carrot variety and included 6 to 8 genotypes commonly grown in Wisconsin and other regions. Phil Simon selected varieties for inclusion in the trial for their good to excellent potential for cut and peel production based on yield, shape, and flavor. Plots were managed with best management practices for fertility and pest management. Plots will be harvested when carrots reach optimal size for cut and peel processing based on root size in mid August, late September, and early November. Carrots from the August harvest were evaluated for flavor. Carrots will also be evaluated for flavor from the September harvest. Carrots from the October harvest will be evaluated for flavor out of the field and then out of storage at 1, 4, and 6 months later. Stored carrots will counted and weighed and then placed in a locker at the storage research facility at Hancock within 24 hours of harvest and cooled to 34 F.

Preliminary results: Flavor evaluations out of storage were completed, but we are still awaiting results. Flavor of carrot has also been evaluated out of first harvest in summer of 09. Second and third plantings of carrot have not reached maturity and have not been harvested at this time.

Objective 2) Quantify moisture loss, shrink, white mold development, and quality of cut and peel carrot when stored for up to 8 months.
Carrots were stored from early November 2008 through June 2009. Research to date has shown that carrot losses due to shrink and disease can be limited in storage through February. However, carrot shrink begins to increase rapidly after 3 months in storage or after the end of February (Figure 1). Primary disease issues was white mold which rapidly increased shrink. Varieties with increased tolerance to white mold may be better suited for long term storage.

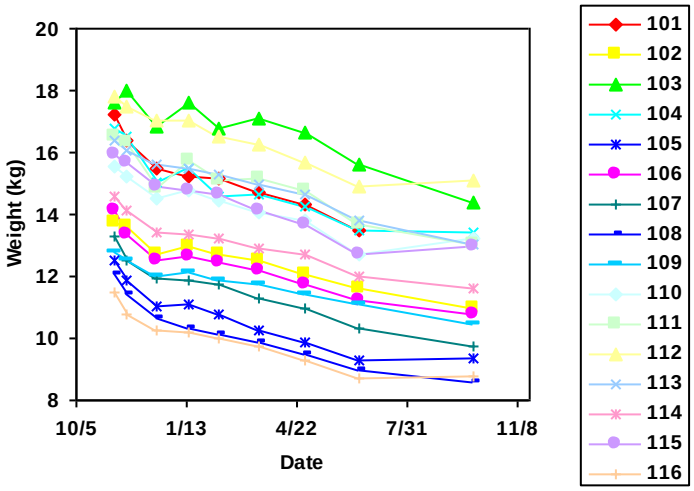

Figure 1. Carrot shrink of multiple varieties in storage

Objective 3. Determine recovery of commercial scale cut and peel carrot samples from the field and from storage. Commercial scale trials were conducted last year in storage and are under development for 2009 – 10 storage season. Commercial quantities of carrot will be stored and evaluated for processing out of storage. Plans are also underway for future commercial evaluation of cut and peel carrot.

Outreach: Results were shared with growers cooperating in the establishment of cut and peel carrot industries in Wisconsin. In addition, pertinent results were disseminated to vegetable processors at the Midwest Food Processors Association, Processing Crops Conference and at the Wisconsin Muck Growers Association annual meeting, and the Wisconsin Fresh Fruite and Vegetable Conference. Cooperative Extension Bulletins on optimal field and storage management recommendations for carrots will be published. In addition, effort is underway to provide guidance to fresh market growers on storage and handling of multiple vegetable crops through separate funding.

Other funding sources: Call for value added producer grants were just announced this week. Proposal is being planned in cooperation with WI carrot growers, vegetable/potato packing sheds, and end users with focus on local and regional foods.