

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

Contract Number: 22031

Grant Project Title: Feasibility Study to Evaluate the Economic Viability of Curly Leaf Spinach

Amount of Funding Awarded: \$10,600

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Report Submitted on: 08/26/08

Please use the following questions as a guide for writing your grant project final report. In your final report, please answer each question as it relates to your grant project.

1) **What was the original intent of the grant?**

This project investigated the feasibility of a Curly-Leaf spinach industry as part of Wisconsin's Agricultural and Industrial economy. The information gained by this project provided the needed support to continue the development of the Spinach Industry in Wisconsin.

• **What did you want to accomplish with the grant?**

There were three objectives to this project. First was to assess whether the Wisconsin region, with similar soils and climates as other Curly-Leaf spinach growing regions, could support the farming of Curly-Leaf spinach as an alternative Wisconsin crop. Second was to detail the economic and logistical attributes of a Wisconsin Curly-Leaf spinach industry and the third was to develop the plan for the next phase of this project which would include appropriate field-trials and launch plan for a Wisconsin based Curly-Leaf spinach industry.

This project met these objectives by producing a comprehensive analysis of all the factors influencing the viability of the potential new crop in Wisconsin. These results were then used to develop the action plan for pilots and field trials and the process of building the supply of Wisconsin grown Curly-Leaf spinach.

• **How was it expected to benefit Wisconsin Agriculture?**

CleenPack out of Milwaukee is a major processor/repacker of Curly-Leaf spinach. With current Curly-Leaf growers located on either the east coast (NY, NJ, Pennsylvania) or the West (Colorado, TX), CleenPack must purchase Curly-Leaf spinach grown out of the state of Wisconsin.

Nearly all flat-leaf spinach is grown and processed on the West Coast and is shipped to the Midwest which gives Curly-Leaf spinach important advantages such as freshness and shelf-life in the local markets.

- **What makes this project work important or significant?**

Sales of Curly-Leaf spinach in the U.S were \$108 million in 2003. The Milwaukee (population 1,689,572), Chicago (9,157,540), and Minneapolis (2,968,806) areas currently has all their fresh spinach shipped in from out-of-state. At 2.6 pounds per capita in metropolitan areas, the potential local market is significant.

Sales of Curly-Leaf spinach in the U.S were \$108 million in 2003. The Milwaukee (population 1,689,572), Chicago (9,157,540), and Minneapolis (2,968,806) areas currently has all their fresh spinach shipped in. At 2.6 pounds per capita in metropolitan areas, the potential local market is significant.

2) **What steps did you take to reach your goal?**

- 1) **Markets and Marketing Issues:** A marketing study on the national Curly-Leaf spinach industry was performed in February 2006. Additional research was performed to focus specifically on Wisconsin and the Midwest.
- 2) **Production Requirements and Analysis of plant/environment compatibility.** We worked with agronomists, UW, seed companies, farmers, repackers and other resources on evaluating the compatibility and production requirements for growing Curly-Leaf spinach in Wisconsin. Items such as location, irrigation, rainfall, temperature, soil condition, pest/disease control, and other information helped us assess whether Curly-Leaf spinach could flourish as part of the Wisconsin crop rotation.
- 3) **Harvesting and Processing:** Curly-Leaf spinach is harvested using fairly unsophisticated cutting equipment. The product is then placed in containers and shipped to processing plants. Wisconsin already has a major Curly-Leaf spinach processor who “imports” all their Curly-Leaf spinach from other states. This study outlined the resources needed to support a Wisconsin based Curly-Leaf spinach industry.
- 4) **Financial Analysis:** This study provided data on financial information such as expected yield and expected demand. We also provided information of expected economic and financial benefits of a Wisconsin Curly-Leaf spinach industry.
- 5) **Intangible Analysis:** A Wisconsin Curly-Leaf spinach industry would also provide social, environmental, and ecological/biodiversity benefits for the state. This study provides information on the benefits of a Wisconsin Curly-Leaf industry.
- 6) **Next Steps:** The most tangible result of this project was to outline the action plan for the next steps of the Curly-Leaf Spinach Industry. Armed with the data collected by this study, we developed and proposed the short term and medium term implementation plans. Short term steps are pilots and field studies aimed at proving and refining spinach production and quality. It also includes initiating a marketing program and consumer/farmer education programs. Medium term steps include the initiation of larger field tests and wide scale communication program.

- **What worked?**

We were successful in properly exploring the different aspects of a Curly-Leaf Spinach Industry in Wisconsin. This project gave us the confidence and information needed to develop, submit and gain approval for the next phase of this project.

- **What challenges did you face?**

The 2006 e-coli outbreak in Flat-Leaf spinach temporarily dampened enthusiasm for growing the spinach industry. Now that the market is nearly fully recovered, enthusiasm has returned

- **What would you do differently?**

Partner with UW-Madison earlier.

3) **What were you able to accomplish? What are the results from this project?**

A comprehensive analysis in the form of a 28 page report
An approved 2008 Department of Agriculture, Trade, and Protection ADD grant.

• **Include any analysis of data collected or materials developed through project work.**

Report Included Separately
2008 Grant Application Attached

4) **What conclusions can you make based on project work the analysis of collected data?**

The Spinach Industry in Wisconsin is viable and we should continue to develop the industry.

5) **What do you plan to do in the future as a result of this project?**

Develop Wisconsin management strategies such as pest control, fertilization, etc. Start scale-up process from field trials to larger-batch production. Please see 2008 ADD grant attached.

6) **What information or additional resources are needed to commercially develop this enterprise?**

Please see 2008 ADD grant attached.

7) **How should the agricultural industry use the results from your grant project?**

To incorporate Curly-Leaf Spinach into Wisconsin's crop portfolio.

Viability Study of a Wisconsin Based Curly-Leaf Spinach Industry

**A report for the Wisconsin Department of Agriculture, Trade, and
Consumer Protection : Agriculture Development and Diversity
Program (ADD)**

**By Kelly Coles
August 2008**

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Executive Summary

The value of a Curly-Leaf (Savoy) Spinach Industry in Wisconsin includes: an introduction of an alternative crop that fits in well with the existing crop rotation cycle, potential to farm in a traditional and environmentally sound manner, and import replacement in an under-developed market that is currently entirely supplied from out-of-state sources.

Our research discovered that spinach consumption was higher in metropolitan cities (2.6 pounds per capita), compared to suburban (2.47 total spinach consumption) and rural (1.81 pounds total) residents' consumption. According to a Curly-Leaf spinach repacker, this is especially true in the local markets with demand for Curly-Leaf spinach in the Chicago/Milwaukee/Minneapolis areas far exceeding the available supply.

There is already a major processor/repacker of Savoy Spinach in Wisconsin. Kleen-Pak is a Milwaukee based produce repacker who has curly leaf spinach shipped in from out of the state. Kleen-Pak bags curly-leaf spinach for Roundy's, Fresh Brands and Certified Grocers, among others. Spinach represents 30% of their revenue.

One assumption going into this project was that Savoy spinach was a better nutritional choice over flat leaf spinach. This project had Covance Labs in Madison, Wisconsin perform a nutritional analysis for comparison purposes. The results show Savoy Spinach to be a much more nutritional alternative to the common flat-leaf (baby) spinach along with other common leafy-green alternatives.

One of the attractions of spinach to Wisconsin growers would be that it is a cool season crop that is raised in the spring, fall, and can be planted as an over-winter crop. Fields are planted using traditional planting methods, managed using common strategies and are harvested using simple harvesting equipment.

Current production is rapidly recovering from the 2006 flat-leaf e-coli outbreak and we see demand at or above the very strong 2000 to 2002 levels. Sales for Savoy (Curly-Leaf) spinach rose to \$108 million per year in 2003 and had remained steady since the outbreak.

It is reasonable to estimate that Wisconsin's initial market could be 500 acres and would grow as the local market grows. A 500 acre Wisconsin Curly-Leaf spinach market could potentially provide \$250,000 in profits to Wisconsin growers. The support services (repackers, etc) could initially see an additional \$100,000 in profit.

For the next phase it is recommended that Research and Development focus on the main areas of risk that need to be quantified and managed.

1. Forward

The Curly-Leaf (Savoy) spinach plant is native to the Middle East and is grown throughout the world. In the United States, Curly-Leaf spinach is primarily grown on the east coast and the southwest and is currently not significantly grown in Wisconsin. This study was implemented to research the feasibility of a Curly-Leaf spinach industry as part of Wisconsin's Agricultural and Industrial economy and to determine if further research is warranted.

It is believed that Curly-Leaf spinach would be an attractive addition to Wisconsin's crop rotation because it is a hearty, high-nutrient, high value crop that thrives in cool weather climates and can even be planted as a winter-over crop.

Curly leaf (Savoy) spinach is distinguishable by its crinkly, curly (or "savoyed") leaves. Its dark green color and springy, crisp texture make it a popular choice for fresh salads or to top off sandwiches. Plus, it is a frequent choice when cooking. Its hearty leaves hold up well in most recipes that call for spinach, from soups and dips to lasagnas and quiches. Curly-Leaf spinach can be purchased loose, bagged and frozen and it's available all year round. The issue in Wisconsin is the distance between the current curly-leaf growers and Wisconsin consumers.

Curly leaf spinach has been enjoyed in the United States for decades and is grown in the East and Southwest. Thought to have originated in ancient Persia (present-day Iran), spinach made its way to China in the 7th century. The Moors liked it so much they brought spinach to Spain. There, Catherine de Medici fell in love with the green, leafy vegetable. So much, in fact, that she took her own cooks and the beloved spinach from Florence, Italy, with her when she married the king of France. Since then, any dishes prepared with spinach are referred to as "a la Florentine." For a while, spinach was known in England as the Spanish vegetable.

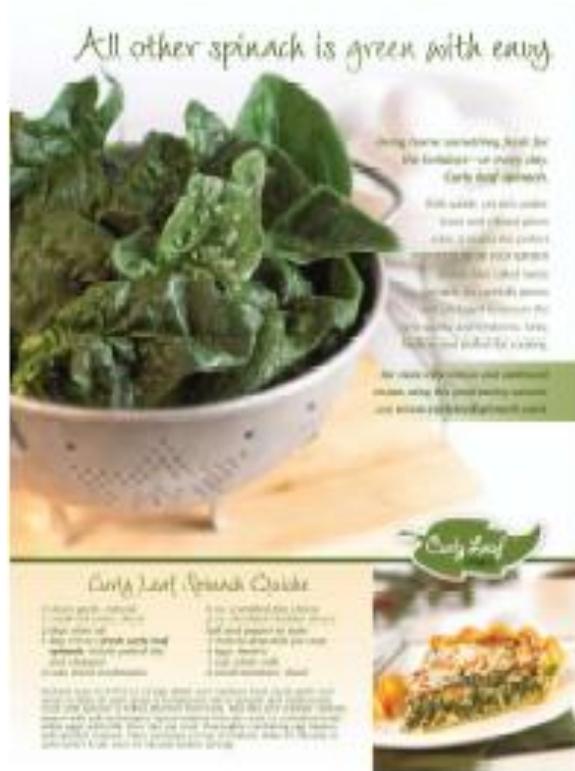
Once it's picked, only curly leaf spinach is packed in specially designed, sanitized, ice-packed containers to maintain nutritional value and ensure the quality and safety of the curly leaf spinach as it is sent to re-packers in the produce industry.

2. Objectives

There are three objectives to this project. First is to assess whether the Wisconsin region has similar soils and climates as other Curly-Leaf spinach growing regions. Second is to provide some detail into the economic and logistical attributes of a Wisconsin Curly-Leaf spinach industry and the third will be to develop the action plan for the next steps for launching a Wisconsin based Curly-Leaf spinach industry.

This project will meet these objectives by producing an analysis of all the factors influencing the viability of the potential new crop in Wisconsin. These results will then be used to develop a plan that includes field trials, lab testing and the process of building the supply of Wisconsin grown Curly-Leaf spinach.

This marketing program also created a Curly-Leaf logo used for marketing efforts along with a series of news releases, and an advertisement in a major national cooking magazine.



With the completion of this feasibility study and the start of the next phase of this project, Tosca Limited is confident enough to initiate a second marketing program to work on better educating the Wisconsin public on the benefits of spinach. Many potential customers (including most restaurants, schools, nursing homes, and institutions) do not even know that Curly-Leaf spinach is an alternative to flat leaf spinach. They may not even consider spinach in general as an alternative to greens such as lettuce.

Strengthen Wisconsin agriculture Industry: Market and Infrastructure Already in Place. Just Add Crops.

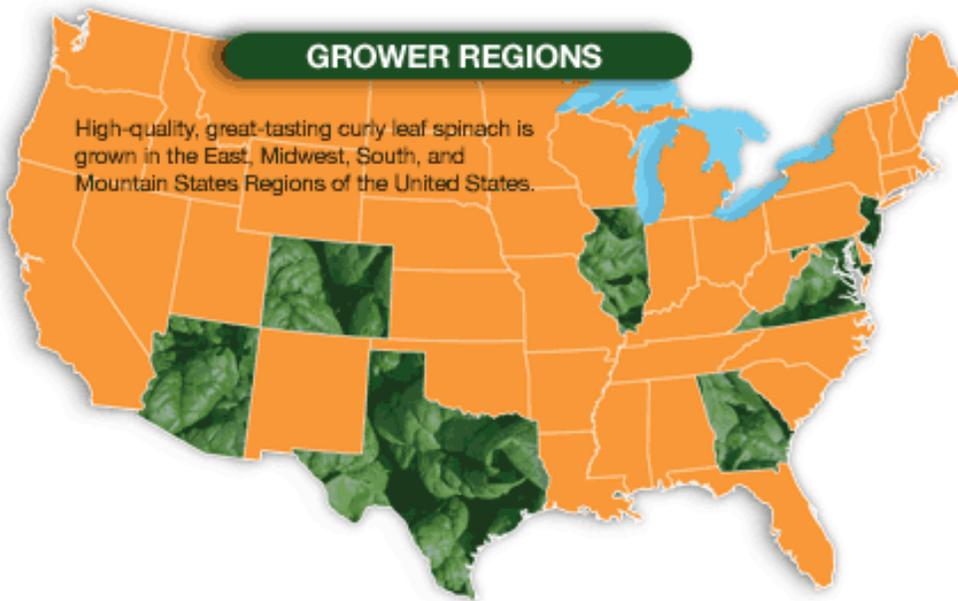
There is already a major processor/repacker of Savoy Spinach in Wisconsin. Kleen-Pak is a Milwaukee based produce repacker who has curly leaf spinach shipped in from out of the state for packaging. Kleen-Pak bags curly-leaf spinach for Roundy's, Fresh Brands and Certified Grocers, among others. Spinach represents 30% of their revenue.

Below is a picture from the Milwaukee Journal of a Kleen-Pak employee processing curly-leaf spinach.



Appendix B : Milwaukee Journal Article

With current Curly-Leaf growers located on either the east or the south-west with an extremely small amount grown in Illinois, local processors such as the one in Milwaukee must purchase Curly-Leaf spinach grown out of the state of Wisconsin.



Nearly all of the Curly-Leaf's competition (flat-leaf spinach and greens) are grown and processed on the West Coast and is shipped to the Midwest which gives Curly-Leaf spinach important advantages such as freshness and shelf-life in the local markets.

In a recent article, Daryl Warncke, MSU professor of crop and soil sciences, and MSU Extension regional vegetable educator, Jim Breinling, were quoted that there are increasingly high demands for frozen spinach in the Midwest but not enough local growers producing the crop. They studied the viability of growing spinach in the Mid-West and found that the crop could thrive here.

A Powerhouse of Nutritional Benefits.

One assumption going into this project was that that Savoy spinach should be a better nutritional choice over flat leaf spinach. This project had Covance Labs in Madison, Wisconsin perform a nutritional analysis for comparison purposes. The results show Savoy Spinach to be a much more nutritional alternative to the common flat-leaf (baby) spinach along with other common leafy-green alternatives.

For example, raw Savoy spinach has 26% more dietary fiber, 46% more protein, 148% more Vitamin C, 140% more Calcium, and 278% more Iron than flat-leaf spinach.

	Units	Curly	Flat
Calories	CL	33.00	20.00
Sodium	MG	194.00	59.60
Total Carbohydrates	GM	3.50	1.80
Dietary Fiber	GM	2.40	1.90
Total Sugar	GM	0.30	0.09
Protein	GM	4.10	2.80
Beta Carotene	MG	3.53	3.05
Vitamin A	IU	5880.00	5080.00
Vitamin C	MG	32.50	13.10
Calcium	MG	162.00	67.30
Iron	MG	5.72	1.51
Moisture	GM	90.40	93.80

Nutritional Comparison between all the common “greens” also shows that Savoy Spinach is a significantly more nutritious option. Appendix A : Nutritional Comparison.

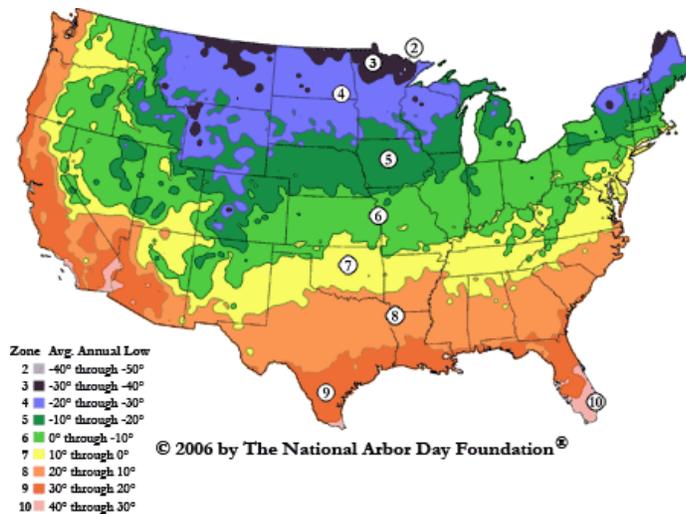
We have provided this information to the produce processors and will incorporate this information into the upcoming marketing program.

3. Production Requirements

One of the attractions of spinach to Wisconsin growers would be that it is a cool season crop that is raised in the spring, fall, and can be planted as an over-winter crop. Fields are planted using traditional planting methods, managed using common strategies and are harvested using simple harvesting equipment.

Climatic Requirements:

Spinach is a member of the Chenopodiacea or Goosefoot family and is closely related to beets & Swiss chard. Spinach is a quick-maturing, cool-season hardy vegetable crop. According to multiple sources, spinach plants are quite hardy and will withstand winters without protection even up to Zone 3 if there's adequate snow cover.



Wisconsin's relatively cool seasons should be ideal for growing high-quality Curly-Leaf spinach.

Soils:

Curly-Leaf spinach prefers nitrogen rich soils, high in organic matter, to help retain moisture. Wisconsin's many "muck" farms are great candidates for the growing of Curly-Leaf spinach. One major advantage to growing spinach on Wisconsin Muck farms is that these farms already provide produce to the local processors (i.e. onions, etc).

A recent research study by Jim Breinling of Michigan State found that muck soils produce high quality spinach.

"We introduced (spinach) to two muck farmers in the Grant area and one in southeastern Michigan; they have had much more success," Breinling said. "Combined, the three farmers grew more than 250 acres of spinach this year. It's not thousands of acres, but there is a market and demand for the product, and it works for these individuals and the processor."

A variety of other soils can also be used for spinach production, and some seed manufactures recommend sand loam soils. They indicate that soils with considerable sand are desirable for because they are warmer and make harvesting during rainy periods possible. Heavier soils can be quite productive if they are well drained. It is also quite salt tolerant relative to other vegetable crops.

The advantage of mineral soils is the good drainage and ease of mechanical processing. The issue with mineral soils for curly leaf spinach is the risk of sand and grit getting into the meat of the plant and reducing the attractiveness to the consumer. By far, the majority of curly-leaf crops in the country are grown on traditional, mineral soils.

All these soil varieties are abundantly available in Wisconsin and further research will include both mineral and muck soils.

Planting:

Spinach is typically grown in two or four rows on beds 38 to 40 inches wide and can also be grown on beds 30 and 60 inches wide. Spinach is direct seeded and seeding rates mostly depend on row configuration and type of seed. Seeding rates range from 9 to 25 pounds per acre. Farmers can sow as many as one million seeds per acre. The seed is sown ½" deep directly into

soil as soon as it can be worked. Seeds take 8-12 days to germinate and plants mature in 42-50 days.

Spinach for processing (frozen and bagged) can be planted in narrow rows, ranging from 10 inches to 12 inches apart. This is often a function of the harvesting equipment and the width of the cutter on the harvester. It is usually planted in 6- to 8-row beds. Final stands should be 7 to 8 plants per foot, although 10 plants per foot are acceptable. Thinner populations will enhance control of foliar diseases because of better air circulation. The plants will also be thicker and blockier.



“Curly-Leaf” varieties of spinach are slow growing and tend to go to seed less quickly and are much better choices for winter-over and spring planting than the “Flat-Leaf” spinach varieties.

There are a number of varieties of Savoy spinach. Seed suppliers indicate that there are three recommended varieties for Wisconsin (early spring/summer production):

- America - Savoy type with dark green leaves, 50 days
- Bloomsdale Long Standing - Savoy, slow to bolt, 48 days
- Tyee -semi-savoyed, 45 days

New Jersey growers provide some insight into how to possibly grow Wisconsin Spinach. In New Jersey, spinach is a cool season crop that is raised in the spring, fall, and overwinter. Fields are planted as a series of beds, each comprised of several narrow-width rows to enhance machine harvesting. Planting dates of beds are staggered so that not all of the spinach in a field is ready for harvest at the same time.

The New Jersey **spring** seeding typically occurs from March 12th to April 20th, placing harvest between May 20th and June 7th. This represents about 30% of the total New Jersey acreage. The **fall** seeding typically occurs from August 10th to August 31st with harvest from September 25th to October 10th. This represents about 50% of the total crop acreage. The **overwinter** seeding

typically occurs from October 1st to 15th, with harvest in the spring. This represents about 20% of the total crop acreage.

The method of harvest and relative size of fields planted depends upon how the crop will be marketed. For processed spinach, the leaves are clipped so that at least two harvests are made from the same planting. Fresh market plantings are harvested once, because the plants are cut and bunched for fresh market. As a result in the difference in marketing, processing fields range from 25 to 300 acres, whereas fresh market fields range from 1 to 10 acres. Usually farmers that raise processing spinach will not also raise fresh market spinach and the reverse is generally true.

Irrigation:

Spinach has a relatively shallow root system and thrives on frequent moderate rain showers to retain an uniform moist soil for maximum leaf production.

This requirement is well met by Wisconsin's damp springs and moderate summers.

Fertilization:

Spinach is a moderately fertilized. The rate of fertilizer should be chosen with consideration of soil type, recent cropping history, and soil test results, which help indicate phosphorus (P) and potassium (k) fertilizer requirements. Some growers broadcast potassium fertilizer and then list their beds. Others apply it in a band 2 to 3 inches to the side and below the seed row after beds are listed but prior to planting.

Pest Management:

Mechanical cultivation, field sanitation, good drainage, and water management should help avoid excessively wet soils. Herbicides, fungicides, and insecticides also are effective countermeasures.

Weed management is essential in spinach production, especially during the seedling stage when dense weed populations reduce spinach seedling vigor and uniformity. Timely cultivations in the early-growth period are required to reduce weed populations, since opportunities for mechanical cultivation decrease as the dense planting rapidly develops a canopy. If present when spinach matures, weeds will interfere with harvest. Nearly all fields are treated with pre-plant and / or pre-emergence herbicides.

An integrated disease management approach including the use of disease-resistant cultivars, crop rotation, careful irrigation, fertility management and fungicides is often necessary to produce high-quality product.

Damping-off disease, Downy Mildew, Blue Mold, White Rust, Leaf Spots (fungi) is problematic in spinach worldwide along with other mold and fungi issues. Management practices typically include the use of a seed-treatment fungicide.

Spinach has relatively few insect pests. Careful inspections are necessary since key pests can cause economic failure in a short time.

In the other growing regions, there are several insect pests known to attack spinach including seed corn maggot, spinach flea beetle, green peach aphid, leaf miners, beet armyworm, garden webworm and grasshoppers. All of these pests can attack both fresh market and processing spinach.

In the next phase of this project, we will work with the University of Wisconsin to develop Wisconsin specific strategies to effectively grow and manager spinach crops.

Harvest

Another advantage to planting Savoy spinach is the ability to have multiple harvests per planting. This constant harvesting tends to stimulate the plant into sending up more leaf shoots and delays the onset of the flower stalk.

Fresh market spinach is field packed. The entire plant is harvested from the time it has five to six leaves to just before seedstalk formation. Plants are cut by hand and tied into bunches of 8 to 12 plants and packed 24 bunches to a carton.

Processing spinach is mechanically harvested using a simple cutting machine which cuts above the growing point so that only the leaves are harvested and the plant can continue growing for a second harvest. The height of the cutting bar can be adjusted to control amount of stem and leaf that is cut. The leaves and a certain percentage of stem are elevated into a plastic bin and transported to the processing plant.

Post-Harvest Handling

Because spinach has a large surface-to-weight ratio and a very high respiration rate, it must be cooled immediately and rapidly to prevent wilting and weight loss. Savoy spinach is very hearty and can withstand much greater compaction and heat then other “leafy greens” such as lettuce and baby-leaf (flat) spinach.

4. Financial Analysis

The U.S. is the second largest producer of spinach beind only China. Wholesale production of spinach was much higher prior to the e-coli outbreak of 2006. Current production is rapidly recovering from the 2006 flat-leaf e-coli outbreak and we see demand at or above the very strong 2000 to 2002 levels. Sales for Savoy (Curly-Leaf) spinach rose to \$108 million per year in 2003 and had remained steady since the outbreak.

Sustainable spinach crops must be productive, competitive and efficient. Product value is determined by the combination of spinach yield and product quality. Quality of the final product includes both tangible (taste, color, appearance etc.) and perceived quality of the final product. The latter refers to consumer concerns about food safety, environmental performance and social responsibility, which must be satisfied.

Typical yields for processing fields are 7 to 12 tons per acre at 18 percent stem. Fresh market spinach sold as leaves can also be mechanically harvested. Plastic bins of loose spinach leaves are trucked to a cooler, cooled, and then transferred by refrigerator truck to the “process facility” where it is tripled-rinsed and packed for market in plastic bags.

In an interview with AJ Bussan, Department of Horticulture – UW Madison, indicated that a yield potential of 5 to 10 tons per acre should provide an attractive crop alternative to Wisconsin framers.

An example of the financial benefits of a local spinach supply comes from a recent study performed by at the Michigan State University. According to the study, fewer than 100 acres of

spinach were grown in Michigan in 2003. In 2004, 300 acres of this crop were grown in the state, bringing new revenue of more than \$150,000 into the state's gross farm economy. The University estimated that a 1,500-acre spinach industry would generate a gross farm gate profit of \$750,000 for Michigan growers. Processing would add additional value and income to the state's economy.

Jim Breinling, Mason County MSU Extension director, said spinach can be a profitable commodity for farmers because the crop can be planted three times a year, as a spring, fall and overwinter crop, and it fits well as part of a crop rotation.

Consumption Information

Sales of Curly-Leaf spinach in the U.S were \$108 million in 2003. A marketing study, performed for this project on Savoy spinach, shows that metropolitan areas are the largest consumers of fresh spinach. The metropolitan areas of Milwaukee (population 1,689,572), Chicago (9,157,540), and Minneapolis (2,968,806) all currently have their fresh spinach shipped in from outside the state of Wisconsin. The same study indicated that consumption is 2.6 pounds per capita in metropolitan areas. The combined population of Milwaukee, Chicago, and Minneapolis is almost 14 million. At 2.6 pounds per capita, the potential local market is significant.

It is reasonable to estimate that Wisconsin's initial market could be 500 acres and would grow as the local market grows. If we extrapolate the MSU study, a 500 acre Wisconsin Curly-Leaf spinach market could potentially provide \$250,000 in profits to Wisconsin growers. The support services (repackers, etc) could initially see an additional \$100,000 in profit.

“Because spinach is perishable, growers must be located reasonably close to processors to generate a profit. Proximity to processors -- in addition to desirable soil types and climate conditions -- opens the door for farmers located along the western Michigan shoreline to grow spinach and make a profit.” (Warncke)

MSU Researcher Warncke noted that further research projects need to be conducted -- on evaluating spinach varieties, establishing proper planting dates and preparing management strategies for certain weather conditions -- to help farmers grow spinach profitably.

“Right now the potential is quite promising for developing a profitable Michigan spinach industry,” Warncke said. “If we develop strategies for managing weeds, insects and diseases, it's possible that Michigan could someday establish a 1,500-acre spinach industry.” We feel that this is also true for Wisconsin.

5. Next Steps:

Appendix C contains the plan for the next phase of this project. Phase two will provide the research needed to address the various open management issues. It will also initiate field trials to accomplish a number of objectives. And finally, this project will explore some of the other value added components to a Wisconsin Curly Leaf Market.

Appendix A : Nutritional Comparison

Nutrients	Units	Curly	Flat	Lettuce, Iceberg	Lettuce, Looseleaf	Lettuce, Romain	Lettuce, Butterhead
Water	g	90.40	93.80	95.890	94.000	94.910	95.580
Energy	kcal	33.00	20.00	12.000	18.000	14.000	13.000
Protein	g	4.10	2.80	1.010	1.300	1.620	1.290
Total lipid (fat)	g	0.350		0.190	0.300	0.200	0.220
Carbohydrates, by difference	g	3.50	1.80	2.090	3.500	2.370	2.320
Fiber, total dietary	g	2.40	1.90	1.400	1.900	1.700	1.000
Ash	g	1.720		0.480	0.900	0.900	0.590

Minerals

Calcium, Ca	mg	162.00	67.30	19.000	68.000	36.000	32.000
Iron, Fe	mg	5.72	1.51	0.500	1.400	1.100	0.300
Magnesium, Mg	mg	79.000		9.000	11.000	6.000	13.000
Phosphorus, P	mg	49.000		20.000	25.000	45.000	23.000
Potassium, K	mg	558.000		158.000	264.000	290.000	257.000
Sodium, Na	mg	194.00	59.60	9.000	9.000	8.000	5.000
Zinc, Zn	mg	0.530		0.220	0.290	0.250	0.170
Copper, Cu	mg	0.130		0.028	0.044	0.037	0.023
Manganese, Mn	mg	0.897		0.151	0.750	0.636	0.133
Selenium, Se	mg	1.000		0.200	0.200	0.200	0.200

Vitamins

Vitamin C, ascorbic acid	mg	32.50	13.10	3.900	18.000	24.000	8.000
Thiamin	mg	0.078		0.046	0.050	0.100	0.060
Riboflavin	mg	0.189		0.030	0.080	0.100	0.060
Niacin	mg	0.724		0.187	0.400	0.500	0.300
Pantothenic acid	mg	0.065		0.046	0.200	0.170	0.180
Vitamin B-6	mg	0.195		0.040	0.055	0.047	0.050
Folate	mcg	194.400		56.000	49.800	135.700	73.300
Vitamin B-12	mcg	0.000		0.000	0.000	0.000	0.000
Vitamin A, IU	IU	5880.00	5080.00	330.000	1900.000	2600.000	970.000
Vitamin A, RE	mcg_RE	672.000		33.000	190.000	260.000	97.000
Vitamin E	mg_ATE	1.890		0.280	0.440	0.440	0.440

Lipids

Fatty acids saturated	g	0.056		0.025	0.039	0.026	0.029
Fatty acids monounsaturated	g	0.010		0.007	0.012	0.008	0.008
Fatty acids polyunsaturated	g	0.146		0.100	0.159	0.106	0.117
Cholesterol	mg	0.000		0.000	0.000	0.000	0.000
Phytosterols	mg	9.000		10.000	38.000		

Amino Acids

Tryptophan	g	0.039		0.008	0.009	0.012	0.009
Threonine	g	0.122		0.053	0.059	0.074	0.059
Isoleucine	g	0.147		0.075	0.084	0.105	0.083
Leucine	g	0.223		0.070	0.079	0.098	0.078
Lysine	g	0.174		0.075	0.084	0.105	0.084
Methionine	g	0.053		0.014	0.016	0.020	0.016
Cystine	g	0.035		0.014	0.016	0.019	0.015
Phenylalanine	g	0.129		0.049	0.055	0.068	0.054
Tyrosine	g	0.108		0.029	0.032	0.040	0.032
Valine	g	0.161		0.062	0.070	0.087	0.069
Arginine	g	0.162		0.063	0.071	0.088	0.070
Histidine	g	0.064		0.020	0.022	0.028	0.022
Alanine	g	0.142		0.050	0.056	0.070	0.055
Aspartic acid	g	0.240		0.127	0.142	0.177	0.141
Glutamic acid	g	0.343		0.162	0.182	0.227	0.180
Glycine	g	0.134		0.051	0.057	0.071	0.057
Proline	g	0.112		0.043	0.048	0.060	0.048
Serine	g	0.104		0.035	0.039	0.049	0.039

Appendix B : Milwaukee Journal Article



Containing the damage

Marketing campaign aims to boost consumer confidence in spinach

By DORIS HAJEWSKI
dhajewski@journalsentinel.com

Posted: Jan. 30, 2007

Green Bay - A Wisconsin-based container company has launched the most expensive marketing campaign in its history to give consumers the straight scoop on curly-leaf spinach and to urge them to buy it.

Tosca Ltd. provides a service to the spinach industry that most people outside the business have never heard of: The company ships and cleans plastic containers that are used to transport spinach safely from growers to re-packers. The re-packers - companies such as Kleen-Pak in Milwaukee - put the produce into plastic bags for sale in supermarkets.

When the U.S. Food and Drug Administration recalled all spinach in September following an E. coli outbreak, all growers and handlers of spinach suffered financially, even those such as Tosca and Kleen-Pak whose products were not linked to the contamination. The outbreak killed three people - including one in Wisconsin - and sickened nearly 200 others.

"We're still feeling the impact," said Michael Fechter, vice president for recyclable plastic containers at Tosca. "A lot of our growers are still at 68 to 70 percent."

Tosca's new marketing effort is aimed at getting the business back to what it was before the September outbreak.

With locations in seven states, Tosca has all of the container business for the curly-leaf growers in the United States. The crop is grown in several regions of the country but not in California.

Kleen-Pak, the only re-packer in Wisconsin, bags curly-leaf spinach for Roundy's, Fresh Brands and Certified Grocers, among others.

The FDA's spinach advisory was in effect from Sept. 14-22, when the source of the tainted spinach was pinpointed to three counties in California.

Those counties grow baby-leaf spinach. The curly-leaf spinach that is shipped in Tosca's containers was never linked to the contamination, but the financial damage was done.

When the spinach ban was announced, everything having to do with spinach was shut down for two weeks at both Tosca and Kleen-Pak. When shipments resumed, the volume was down, mostly because supermarkets just didn't want to buy as much while consumers were still skittish about eating it.

"The day it was on CNN, we asked ourselves, 'What can we do?'" said Charity Schneider, account manager for Tosca's spinach container business, which accounts for about 10% to 12% of total revenues.

There is no trade group for the curly-leaf spinach industry, so there was no established network to deal with the crisis.

Tosca, a company that previously had never done any consumer-oriented marketing, decided to step up.

"We knew we needed a PR firm, not so much to rebut, but to provide information about what was happening," Fechter said.

Curly vs. flat-leaf

Since September, Tosca has spent more than \$100,000 for the effort, including news releases; a Web site, www.curlyleafspinach.com; and a full-page ad in the December issue of Cooking Light magazine.

With a goal of boosting sales of curly-leaf spinach, the marketing message includes an explanation of the difference between curly-leaf spinach, which is also known as savoy spinach, and the baby spinach that was involved in the contamination outbreak.

Curly-leaf spinach has been available in the United States for 100 years, and is grown in the East, Midwest, South and mountain states regions of the country. Growers are located in Illinois, Texas, Colorado, Arizona, Georgia, Virginia, Maryland and New Jersey.

Flat-leaf, or baby spinach, has gained popularity in the past decade.

One thing the marketing campaign does not do is to make any claims suggesting that curly-leaf spinach is safer than the flat-leaf.

"We were very cautious in our campaign," Fechter said. "We're not immune to problems. This could happen to any fresh product."

Sales slow to rebound

Tosca's plastic containers were introduced in 1996, replacing the bushels that the industry used. Bushel

baskets couldn't be sanitized and didn't have lids. Tosca's reusable plastic baskets allow for drainage for the ice that is packed with the spinach, and the baskets are sanitized at Tosca facilities before being recycled back to the fields.

Re-packers, such as Kleen-Pak, wash the spinach before bagging it. Kleen-Pak processes about 500,000 pounds of spinach each year. Spinach is the second-largest part of Kleen-Pak's business, behind onions.

Immediately after the E. coli outbreak in September, Kleen-Pak and other re-packers started marking spinach packages with the state of origin. The locations vary with the seasons.

The re-packers also are using the new curly-leaf spinach icon logo that was developed as part of Tosca's marketing campaign.

Kleen-Pak's spinach volume now is at about 80% of what it was before September, according to Jerry Kowaleski, a co-owner of the company.

"There's plenty of supply," Kowaleski said. "The demand isn't what it used to be. If we could sell more, we would."

Vivian King, spokeswoman for Roundy's, said spinach sales were on a slow but steady rebound.

"Customers are buying spinach again, but not at the level they were prior to the spinach recall," King said.

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Appendix C : ADD Grant Application

2008 Agricultural Development & Diversification (ADD) Grant Proposal

Project Title: **Development of a Curly Leaf (Savoy) Spinach Industry in Wisconsin**

Project Start Date: July 1, 2008

Proposal Concept Statement

Based on the favorable results generated by the 2007 Feasibility Study to Evaluate the Economic Viability of Curly Leaf (Savoy) Spinach Industry in Wisconsin, this project will provide the research needed to address the various open management issues. It will also initiate field trials to accomplish a number of objectives. And finally, this project will explore some of the other value added components to a Wisconsin Curly Leaf Market.

Proposal Background and Description of Market Opportunity

Tosca is developing a feasibility study for the Viability of Curly Leaf (Savoy) Spinach Industry in Wisconsin. The objective of this study is to assess whether the Wisconsin region, with similar soils and climates as other Curly Leaf (Savoy) Spinach growing regions, could support the farming of Curly Leaf (Savoy) Spinach as an alternative Wisconsin crop. It is also aimed to initiate the development of a production system and the market development for Wisconsin Curly Leaf (Savoy) Spinach.

The initial results of the viability study are overwhelmingly favorable. The study is finding that Curly Leaf (Savoy) Spinach crops can thrive in Wisconsin conditions. The study is also finding that the market conditions are right for a vibrant Curly Leaf (Savoy) Spinach industry in Wisconsin.

High fuel prices, worker conditions, and sanitation (e-coli) issues on the west coast (and other regions) makes products that compete with Curly Leaf (Savoy) spinach unattractive. Flat Leaf (Baby) spinach is grown on the west coast and is shipped throughout the country for consumption. The conditions that Curly Leaf (Savoy) Spinach is grown and processed in help reduce the risk of sanitary issues such as e-coli or salmonella. Because the product is grown locally, significant savings can be realized through reduced shipping and preservation costs.

The study is also finding that Curly Leaf (Savoy) Spinach is most popular in urban areas. Wisconsin is ideally situated to provide Curly Leaf (Savoy) spinach to the Midwest's major metropolitan areas such as Milwaukee, Chicago, Minneapolis, and Detroit.

The feasibility study has proven that Curly Leaf (Savoy) Spinach provides superior nutritional value compared to flat leaf spinach and all other "leafy green" alternatives. Raw Curly Leaf (Savoy) Spinach has 26% more Dietary Fiber, 46% more Protein, 148% more Vitamin C, 140% more Calcium, and 278% more Iron than flat-leaf (baby) spinach. The nutritional comparisons between all the common "greens" such as lettuce show that Curly Leaf (Savoy) spinach is also a significantly more nutritious option.

Project Objectives and Plan of Work

Based on the favorable results generated by the 2007 Feasibility Study to Evaluate the Economic Viability of Curly Leaf (Savoy) Spinach Industry in Wisconsin, this project will provide the research needed to address the various open management issues such as:

- Optimizing production to meet demand and quality parameters
- Interactive effects of time to harvest, row spacing, and density on leaf characters (petiole size, leaf size)
- Time of planting effects on quality
- Insect management
- Weed management
- Disease management

This project will initiate field trials. These trials will accomplish a number of objectives such as:

- Best management as we currently know it

- Vigilant evaluation of crop growth and quality to optimize harvest
- Mechanical harvest of crop
- Delivery and repack (determine recovery)
- Profitability for suppliers, growers, repacker

This project will also explore some of the other value added components to a Wisconsin Curly Leaf Market such as:

- Local labeling
- Sustainability components such as “Carbon Footprint”, etc
- Organic

Finally, this project will initiate the activities needed to promote Curly Leaf (Savoy) as a viable Wisconsin industry such as a marketing plan.

Tosca will partner with the University of Wisconsin Department of Horticulture to achieve the majority of the objectives of this project. Attached is the description of University’s role in this project.

Project Results and Expected Economic Impact

The relative success of growers and processors to produce and package spinach is confirmation that production systems can be identified and optimized to allow for profitable fresh market production. Proposed research is needed to address differences in Savoy and flat leaf spinach and the tighter quality specifications for fresh market spinach.

The proposed project is also needed to explore the other value added components of a Wisconsin Curly Leaf (Savoy) spinach market and will provide the needed momentum to initiate the growing, processing, and sale of Wisconsin Curly Leaf (Savoy) spinach.

2008
Agricultural Development & Diversification (ADD)
Grant Proposal Cover Sheet

Subcontract to Tosca Limited grant entitle 'Feasibility Study to Evaluate the Economic Viability of Curly (Savoy) Spinach Industry in Wisconsin'

Tosca Limited Contact: Kelly Coles, V.P. Operations, 1032 Bay Beach Rd Green Bay, WI 54308, (920)-617-4041, KColes@ToscaLtd.com

Project Title: Development of production profile for Savoy spinach under Wisconsin conditions

Amount Requested: \$12,000

Full Legal Name of Applicant/Organization:

Alvin J. Bussan **Board of Regents of the
University of Wisconsin System
Research & Sponsored Programs
21 North Park Street, Suite 6401
Madison, WI 53715**
Dept. of Horticulture
UW-Madison

Applicant's Address: 1575 Linden Drive, Madison, WI 53706

Name and Title of individual(s) that can execute a contract for the Applicant:

Diane Barrett
Assistant Director, Pre-Award Services
University of Wisconsin Madison, Research and Sponsored Programs
21 N. Park, Suite 6401
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Name of Primary Contact: Alvin J. Bussan

Telephone: 608-262-3519

Email: ajbussan@wisc.edu

Web: horticulture.wisc.edu

County of Project Location: Jefferson, Dane, Outagamie

Project Start Date: 7/1/08

Project Completion Date (Proposed project must be completed within three years.): 6/30/09

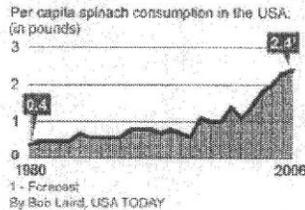
Proposal Concept Statement (3-4 Sentences)

Describe the primary purpose of the proposed project.

This project will investigate the feasibility of a Curly-Leaf spinach industry as part of Wisconsin's Agricultural and Industrial economy. Curly-Leaf spinach is a hearty, high-nutrient, high value crop that thrives in cool weather climates and can even be planted as a winter over crop. Specific goal is to development a suite of management recommendations to provide growers to optimize productivity. Objectives will 1) identify varieties suitable for production on muck soils 2) determine optimal planting rate 3) develop labeled weed management practices and 4) quantify effect of planting date on yield and quality, sensitivity to insects, and appropriate insect management techniques. If successful, this study will provide the information and testing needed to prove that the Curly-Leaf spinach crop can provide value as part of Wisconsin's crop rotation cycles and can be a sustainable industry in Wisconsin.

Proposal Background and Description of Market Opportunity. The Curly-Leaf spinach plant is native to the Middle East and is grown through the world. In the United States, Curly-Leaf spinach is primarily grown on the east coast and the southwest. Spinach was grown and processed in Wisconsin up until the mid-90's, but was primarily the flat leaf type. Fresh market vegetable growers produce small plots of spinach all across Wisconsin. There is little information available on optimal management guidelines for Savoy spinach in Wisconsin as it has never been grown commercially in Wisconsin and no commercial production has been undertaken for at least 10 years.

Opportunity for Wisconsin: Demand for the product.



In a market research performed by Dr. Bridget K. Behe, Ph.D., in February 2006, the wholesale production or farm value of spinach (fresh and processing) averaged \$162 million per year from 2000 to 2002, with the value of fresh-market spinach doubling in the past decade. The Economic Research Service estimated 457 million pounds for fresh-market spinach were produced for domestic consumption in 2003. According to Dr. Behe, triple-washed and packaged spinach is one of the fastest growing segments, particularly from the demand increase in flat-leaf spinach. Sales in flat-leaf spinach rose 70% between September 2002 and August 2003 to \$116 million. During the same period, Curly-Leaf (Savoy) spinach increased 7% to \$108 million.

The same research discovered that spinach consumption was higher in metropolitan cities (2.6 pounds per capita), compared to suburban (2.47 total spinach consumption) and rural (1.81 pounds total) residents' consumption. According to CleenPack, a Milwaukee based Curly-Leaf spinach repacker, this is especially true in the local markets with demand for Curly-Leaf spinach in the Chicago/Milwaukee/Minneapolis areas far exceeding the available supply.

With the recent Flat-Leaf spinach e-coli issue, a major marketing program is underway to help differentiate and grow the Curly-Leaf spinach market. The same marketing program is working on better educating the public on the benefits of spinach. Many potential customers (including most restaurants, schools, nursing homes, and institutions) do not even know that Curly-Leaf spinach is an alternative to flat leaf spinach. They may not even consider spinach in general as an alternative to greens such as lettuce. Spinach is loaded with 13 different compounds that work as antioxidants, which are cancer-fighting agents in the human body. Spinach is also a terrific source of vitamin K for strong bones, lutein for healthy eyes, vitamin C and Beta-carotene for cholesterol reduction, and iron for a stronger body.

Strengthen Wisconsin agriculture Industry: Market and Infrastructure Already in Place. Just Add Crops.

CleenPack out of Milwaukee is a major processor/repacker of Curly-Leaf spinach. With current Curly-Leaf growers located on either the east coast (NY, NJ, Pennsylvania) or the West (Colorado, TX), CleenPack must purchase Curly-Leaf spinach grown out of the state of Wisconsin.

Several Wisconsin farmers produced spinach for Dean Foods for processing as recently as the mid 90's. Many of these growers have production records from when they grew spinach during that time. Spinach was primarily grown on muck soils as they were well suited to meeting nutrient demands of the spinach crop. In addition, spinach was primarily produced in early spring to avoid insect issues that were much more prevalent in summer and early fall. To meet fresh market demand, production systems specific to Savoy spinach will need to be devised to provide raw product throughout the summer and meets quality requirements for packaging.

Nearly all flat-leaf spinach is grown and processed on the West Coast and is shipped to the Midwest which gives Curly-Leaf spinach important advantages such as freshness and shelf-life in the local markets.

Viable Opportunity: Hearty, Cool Weather Crop that Currently Grows in Similar Soils/Climates.

Curly-Leaf spinach is a cool season crop that is raised in the spring, fall, and can be planted as a over-winter crop. Fields are planted as a series of beds, each comprised of several narrow-width rows to enhance simple machine harvesting.

The method of harvest and relative size of fields planted depends upon how the crop will be marketed. For processing spinach, the leaves are clipped so that two harvests are made from the same planting. Fresh market plantings are harvested once, because the plants are cut and bunched for fresh market. As a result in the difference in marketing, processing fields range from 25 to 300 acres, whereas fresh market fields range from 1 to 10 acres.

Project Objectives and Plan of Work

The specific goal of this project is to develop a suite of management recommendations to optimize commercial production of Savoy spinach in Wisconsin. Initial research will be focused on muck soils as growers have experience producing spinach in these locations. Specific Objectives include:

- 1) Identify varieties suitable for production on muck soils
- 2) Determine optimal planting rate
- 3) Develop labeled weed management practices
- 4) Quantify effect of planting date on yield and quality, sensitivity to insects, and appropriate insect management techniques.

Approach:

Objective 1. Identify varieties suitable for production on muck soils.

Growers who produced spinach for processing up until the 90's repeatedly cautioned us about spinach variety selection. Spinach varieties differed dramatically in there ability to resist/tolerate

soil born diseases. Susceptible spinach varieties planted in early spring on muck soils that were cool and wet would be exposed to extreme disease pressures from pathogens such as pithium or rhizoctonia. Dave Fischer commented that he had 100% stand losses with some varieties due to susceptibility to soil born pathogens, but that tolerant varieties had little to no stand issues. As such, all growers requested variety specific information on how well spinach established on muck under Wisconsin conditions.

Multiple Savoy spinach varieties will be solicited from seed dealers across the U.S. and planted in replicated trials in collaboration with Dave and Jim Fisher, Mintland Farms, Cory Kincaid, Dean Kincaid Inc., or Tom Phillippi, Leach Farms. Research plots will be established early in the spring to expose spinach varieties to cool and wet soil conditions that are favorable for development of soil born diseases. Varieties will be evaluated for stand establishment and productivity 2 and 4 weeks after planting and harvested at maturity for yield.

Objective 2. Determine optimal planting rate

Spinach planting rate will be evaluated based on previous production experience. Spinach was initially produced on muck soils that were tilled to ensure a flat seed bed. Spinach will be planted in rows spaced 9 to 20 inches apart. Spinach will be also be planted at three in-row densities allowing for spacing between the plants of 6, 9, and 16". Spinach yield and quality will be quantified. Spinach quality characteristics include petiole length and leaf size. Densities need to be established the minimize petiole length as it is undesirable for fresh consumption, but maximum leaf size.

Objective 3. Develop labeled weed management practices

Weed management in spinach on muck soils is challenging due to the limited number of labeled herbicides, potential interaction between high organic matter content of muck soil and incorporated herbicides, and diverse weed community commonly found in muck production fields. Furthermore, spinach packers have little tolerance for weeds as they contaminate the end product and are expensive to sort and remove. This is especially true for weeds with similar leaf size and shape as spinach such as tall waterhemp which is prevalent in Wisconsin muck farms.

Growers who grew spinach relied exclusively on hand weeding in spinach previously due to issues with effective weed management programs. Herbicides labeled through local special needs provisions (24c) such as Dual could be extremely valuable for management of weeds in spinach on muck soil. Dual and other appropriate herbicides will be evaluate for crop safety in spinach (herbicide tolerance) and effectiveness on weeds common in muck production fields.

Objective 4. Quantify effect of planting date on yield and quality, sensitivity to insects, and appropriate insect management techniques.

Spinach has a short growing season only require 42 to 54 days to mature after planting depending on planting date and growing conditions. Climatic conditions can change growth of spinach with warmer conditions leading to more rapid bulking. Warm conditions can also vary flavor. Spinach will be planted monthly from April through September to determine days to harvest, flavor, petiole size, and leaf size.

Planting date also changes the range of insect pressures that spinach will be subjected to. Spinach traditionally was planted early spring to avoid insect pressure. Late planted spinach plantings were infested by a range of insects including grasshoppers. Insects that feed on foliage of spinach or burrow into petioles would cause huge quality losses and require by passing fields as insect damage is nearly impossible to sort from high quality spinach. Due the fresh consumption of spinach leaves thresholds are low relative to other crops. Research will be conducted to develop insect management programs for spinach for spring and summer planting dates. Labeled insecticides will be evaluated with close attention paid to use of products with appropriate preharvest intervals.

Project Results and Expected Economic Impact

The relative success of growers and processors to produce and package spinach is confirmation that production systems can be identified and optimized to allow for profitable fresh market production. Proposed research is need to address differences in Savoy and flat leaf spinach and the tighter quality specifications for fresh market spinach.

Key Personnel

Alvin J. Bussan, Vegetable Cropping Systems Specialist, Department of Horticulture, UW-Madison, 608-262-3519.

Jed Colquhoun, Weed Scientist in Horticultural Crops, Department of Horticulture, UW-Madison, 608-890-0980.

Russ Groves, Vegetable Entomologist, Department of Entomology, UW-Madison, 608-262-3229.

Ken Williams, Extension Agent, Waushara County, 920-787-0416.

Key References

- "The trick to growing spinach is not growing it in season"- Eliot Coleman, The New Organic Grower : Apr 13, 2001
- <http://www.arborday.org/media/zones.cfm>
- "Crop Profile for Spinach in Delaware" www.ipmcenters.org/cropprofiles/docs/DEspinach.pdf
- UNILEVER GOOD AGRICULTURAL PRACTICE GUIDELINES : SUSTAINABLE SPINACH
- "Michigan Growers Venture into Spinach Industry" : http://www.maes.msu.edu/news/news_December2004.htm
- "MSU Researchers Determine Spinach May Have Mucky Michigan Future" : Michigan State College of Agriculture and Natural Resources Newsletter : 10/12/07
- "Containing the damage" : Journal Sentinel : Jan. 30, 2007
- Multiple Interviews with growers on east coast and southeast
- Interview with AJ Bussan, Researcher : UW Madison Department of Agriculture
- Tosca Contracted Project Specific Marketing Study : Knowledge Networks 2006
- Tosca Contracted Market Research Program : Dr Bridget Behe, Ph.D.
- Tosca Contracted Nutritional Study : Covance Labs : 2007
- "Seeing Local Produce in the Grocery Aisle" : A Wisconsin Perspective : 2008 Volume 1
- "Spinach Production in California" : University of California Vegetable Research and Information Center : Publication 7217
- "Crop Profile for Spinach in Delaware" : University of Delaware College of Agriculture : 1999
- "It's Growing On Us" : Washington Post : March 30, 2005
- "Factors Affecting Spinach Consumption in the United States" : VGS-300-01 : Jan 2004