FY 2011 SPECIALTY CROP BLOCK GRANT PROGRAM- FARM BILL

North Dakota Department of Agriculture

FINAL REPORT
USDA Agreement # 12-25-B-1247

CONTACT:
Emily Edlund, Specialty Crop Grant Administrator
600 E Boulevard Ave #602
Bismarck, ND 58505-0020
Phone: (701) 328-2191
Email: edlund@nd.gov

Submitted: August 27, 2014

Table of Contents:

PROJECT 1: ELIMINATING SUNFLOWER RUST IN CONFECTION SUNFLOWER THROUGH AGGRESSIVE BREEDING AND ISOLATE IDENTIFICATION

Final Report

Project Summary

Sunflower rust *Puccinia helianthi* is a serious disease that has been increasingly prevalent in much of the U.S. sunflower producing region. Confection sunflower is particularly vulnerable to the disease. The disease can dramatically lower yield and reduce quality of the seed. Developing genetic rust resistance in confection hybrids is the goal of this project. The project will incorporate three identified rust resistant genes into two acceptable confection genetic backgrounds and make them available to the private seed industry for incorporation into finished commercial hybrids. The resistant genes will be molecularly 'marked' for ease of identity in the numerous backcrosses that will be required. Resistance to rust is an important agronomic factor in keeping U.S. confection sunflower competitive in key international markets.

Project Approach

Our approach has three parts. First, we made two to three generations of backcrosses each year. Approximately eight generations with plant material introgressed a resistant gene will be required for the final product. We now obtained BC_3F_4 and BC_4F_4 generations for three combinations. Rust screening was applied to each generation to select resistant plants for backcross. Second, we developed molecular markers linked to the rust resistance genes R_4 and R_5 which are the current candidate genes of choice for introgressing into confectionery sunflower. Molecular markers linked to two new rust resistance genes, R_{11} and R_{12}, were also developed in line Rf-ANN 1742 and RHA 464 which are resistant to rust race 777, most virulent race currently known. Continued presence of the rust resistant gene will be confirmed by genetic DNA markers. In addition, each generation will show agronomic improvement in terms of plant vigor, plant height, seed size and seed color. These are all quantitative factors. Third, we are working on mapping of new rust resistance genes found in the inbred lines HA-R6, HA-R8, and RHA 397. The line HA-R6 is the only confection type known harboring a rust resistance gene.

Goals and Outcomes Achieved

The goals for 2012

1. Select homozygous rust resistance plants from BC_3F_2 and BC_4F_2 populations by combining DNA markers and rust tests and advance them to BC_3F_3 and BC_4F_3.
2. Evaluate agronomic characteristics of selected resistant BC_3F_3 and BC_4F_3 lines in the field.
3. Complete allelic analysis of new rust resistance genes among HA-R6, HA-R8, RHA 397, and RHA 464.
4. Develop DNA markers linked to the rust resistance gene in HA-R6, a confectionery sunflower.

Outcomes achieved in 2012

1. Selection of BC_3F_3 and BC_4F_3 homozygous plants

The crosses were made between CONFSCL B1 and both MC29 (harboring rust resistance gene *R_2*) and HA-R2 (harboring *R_5* gene), as well as between CONFSCL R5 and HA-R3 (harboring *R_4* gene) in the greenhouse in the winter of 2009. The rust tests were applied in each generation to issue that the resistant plants were selected and backcrossed to the recurrent parents. We obtained the BC_4F_2 generation of two crosses with rust resistance genes, *R_2* and *R_4*, and the BC_3F_2 generation of the gene *R_5* in the winter of 2011. We screened 600 BC_3F_2 and BC_4F_2 plants by DNA markers which were identified in the Years 1 and 2 of the project. Sixteen, 24, and 24 BC_3F_2 and BC_4F_2 plants were selected as homozygous resistant individuals harboring the rust resistance genes, *R_2*, *R_4*, and *R_5*, respectively, based on marker data, and advanced them to BC_3F_3 and BC_4F_3 generations in the spring of 2012.

2. Evaluation of agronomic characteristics of selected resistant BC_3F_3 and BC_4F_3 lines in the field

Twenty three BC_3F_3 and BC_4F_3 families for the introgressed rust resistance genes, *R_2*, *R_4*, and *R_5*, were planted and evaluated for their agronomic performance in the Fargo field in the summer of 2012. Meanwhile, we tested the selected BC_3F_3 and BC_4F_3 families for their reaction to rust in the greenhouse. Fourteen F_3 families with R-genes, *R_4* and *R_5*, showed no segregation for rust resistance, indicating that they are homozygous, which was consistent with marker data. However, all F_3 families with the gene *R_2* segregated for rust resistance, indicating they are heterozygous. The previously reported DNA marker by other group was either not closely linked to the gene or was wrong mapped. About 400 heads were begged and harvested from the Fargo field.

3. Completion of allelic analysis of new rust resistance genes among HA-R6, HA-R8, RHA 397, and RHA 464

From our previous survey, four USDA-released lines, HA-R6, HA-R8, RHA 397 and RHA 464 are resistant to both rust races 336 and 777. The rust resistances in these lines are from different origins, indicating diverse genetic sources. Six F_2 populations from the half-diallel crosses of HA-R6, HA-R8, RHA 397, and RHA 464, a total of 1,300 plants, were screened with rust race 336 in the greenhouse in 2012. Among six F_2 populations, segregation for rust resistance was observed in five F_2 populations. No susceptible plants were detected among 220 plants in the cross HA-R6/RHA 397, indicating that the gene in HA-R6 is tightly linked to the resistance gene in RHA 397 or the two genes are allelic. The allelism test demonstrated that the rust resistance gene *R_{12}* in RHA 464 is not allelic to the rust resistance genes in HA-R6, HA-R8 and RHA 397, and the resistance gene in HA-R8 is also independent from the *R*-genes in HA-R6 and RHA 397.

4. Development of molecular markers linked to rust resistance genes *R_{13a}* in HA-R6 and *R_{13b}* in RHA 397

Above allelism test indicated that rust resistance genes in HA-R6 and RHA 397, an oilseed-type restorer line, are either allelic or closely linked. Two populations of 140 $F_{2:3}$ families each from the crosses of HA 89, as susceptible parent, with HA-R6 and RHA 397 were inoculated with rust

race 336 in the greenhouse. The rust resistance gene in the confection sunflower line HA-R6 was mapped to linkage group (LG) 13, flanked by the same molecular markers at the same position as the rust resistance gene in the oilseed sunflower line RHA 397, and thus, these two genes were designated as R_{13a} and R_{13b}, respectively. The DNA markers RGC15/16 and a newly developed marker SUN14 narrowed down the region flanking R_{13a} and R_{13b} into 4.9 cM and 0.1 cM, respectively. Both R_{13a} and R_{13b} are highly effective against all rust races tested so far. Our newly developed molecular markers will facilitate breeding efforts to pyramid the R_{13} genes with other rust *R*-genes and accelerate the development of rust-resistant sunflower hybrids in both confection and oilseed sunflowers.

5. Fine mapping of the rust resistance gene R_{12} in RHA 464 with SNP markers

In our previous mapping efforts, we have identified SSR markers linked to R_{12}. However, a dominant marker, ZVG53, is proximal to R_{12} with a genetic distance of 9.6 cM. The same F_2 population from the cross of HA 89 and RHA 464 was used to construct a high-density SNP map. Combining our rust phenotype data with SNP genotype data we identified seven SNP markers flanking R_{12} at a genetic distance of 1.2 and 1.3 cM, respectively. We validated these SNPs in a large population of 550 sunflower inbred lines and Plant Introduction (PI) lines and found that two SNPs, NSA_003426 and NSA_004155,were at best closely linked to R_{12} because none of 550 tested lines had RHA 464 alleles. These SNP markers have been used to marker-assisted selection in sunflower breeding programs.

6. Pyramid rust resistance genes in confection sunflower

Pyramiding multiple resistance genes from diverse sources into a single host genotype allow creating new breeding lines with more broad-spectrum and long-lasting resistance features. Crosses were made between confection HA-R6 with confection lines carrying *R*-genes, R_2, R_4 and R_5 introduced from oil sunflower, respectively. The F_2 seeds of three hybrids were harvested recently and will be screened to identify the plants carrying two *R*-genes using previously developed DNA markers.

7. Re-location of the rust resistance gene R_2

The previously published DNA markers by Australia group did not show closely linkage to the rust gene R_2 in CM 29, which makes impossible to select R_2 gene based on marker data. We are working on remapping of the gene R_2. A new F_2 population derived from the cross of HA 89 and CM 29 was planted in the greenhouse and F_3 seeds were harvested on December, 2012. Bulked segregant analysis indicated that the gene R_2 was located on LG14 instead of LG9 as previously reported. The new DNA markers linked to R_2 will be developed to facilitate selection of R_2 in our rust gene pyramiding project.

Beneficiaries

The beneficiaries are broad and varied. It is estimated that 825 farmers nationwide (half of whom are in North Dakota) will benefit directly by rust resistant hybrids. The cost of a fungicide application varies between $14 and $24 per acre, depending on which fungicide is used. With an

average cost of $17.30 per application, the costs would equate to $6 million nationally of which $3 million would be in North Dakota. In early and severe infestations confection sunflower fields would require up to three applications resulting in costs of $18 million nationally and $9 million in North Dakota. Those farmers choosing not to spray a fungicide could lose 80 percent of their potential yield and the remainder of the crop would not be marketable. In an experimental strip in 2008 near Minot ND the yield was reduced from 1400 pounds/acre to 400 pounds/acre when no fungicide was used. That yield loss represents $350 per acre. The unmarketable remaining 400 pounds of production due to low test weight and discolored seed would represent an additional $140 per acre. Host resistance is the most effective way to control the disease and reduce the yield loss.

For the past three years the lead scientist or the post-doctoral scientist have reported their results and progress at the annual NSA Sunflower Research Forum held in Fargo ND. Approximately 30 growers and crop consultants* attend that meeting annually. These are growers who are leaders in the industry. These reports are archived on the National Sunflower Association (NSA) website. It is estimated that 200 growers and crop consultants have accessed these reports annually. The Research Forum audience also consists of public and private sunflower breeders. It is these individuals who will take the project to the final step of incorporating the identified resistant genes into their elite germplasm and then cross into finished hybrids. It is these hybrids that farmers will be planting. Hybrid seed companies will be advertising in public media that their confection hybrids have these new rust resistant genes. Dr. Sam Markell, North Dakota State Extension Pathologist (cooperating scientist on this project), will be providing information to growers and crop consultants at 20 information meetings over the next two years. An Extension publication may also be produced. It is estimated that 50 crop consultants and growers will be reached by each of these meetings. The Extension publication will reach 2,000 growers, county agents and crop consultants.

The Sunflower magazine, a publication owned by the NSA, will be summarizing this project in an upcoming issue. This publication is mailed to all sunflower producers and will reach well over 10,000 growers. The article will be of special interest to the estimated 825 confection sunflower growers and another 500 crop consultants. The article will be archived on the NSA website for future reference for growers, consultants and breeders.

*Crop consultants are a very important group to reach since they advise their farmer clients on all aspects of crop production from seed selection to harvesting.

Lessons Learned

One result that was largely unanticipated was the lack of resistance to newer races of rust in the sunflower Plant Introductions that were previously classified as rust resistant in the sunflower GRIN (Germplasm Resources Information Network) database. It demonstrates that "rust resistant" lines must be checked for resistance to the new rust races before enlisting them into breeding programs. Another unexpected result was SSR marker ORS333 linked to the gene R_2 (Lawson et al 2011). We have selected six BC_4F_2 plants that were classified as homozygous plants based on marker data. However, in subsequent rust testing of BC_4F_3 families derived from the selected BC_4F_2 plants, all showed heterozygous features. It demonstrates that published

markers need to be validated, in many cases, in a range of populations representative of the breeding material to be routinely screened.

Contact

Tina Mittelsteadt
2401 46th Avenue SE, Suite 206
Mandan, ND 58554-4829
Phone: 701-328-5138
E-mail: TinaM@sunflowernsa.com

Additional Information

Publications

1. Qi L L, Gulya T, Seiler GJ, Hulke BS, Vick BA 2011. Identification of resistance to new virulent races of rust in sunflowers and validation of DNA markers in the gene pool. Phytopathology 101:241-249.

2. Qi L L, Hulke BS, Vick BA, Gulya T 2011. Molecular mapping of the rust resistance gene R_4 to a large NBS-LRR cluster on linkage group 13 of sunflower. Theoretical and Applied Genetics 123:351-358.

3. Qi LL, Gulya TJ, Hulke BS, Vick BA 2012 Chromosome location, DNA markers and rust resistance of the sunflower gene R_5. Mol. Breeding 30:745-756

4. Qi LL, Seiler GJ, Vick BA, Gulya TJ 2012 Genetics and mapping of the R_{11} gene conferring resistance to recently emerged rust races, tightly linked to male fertility restoration, in sunflower (*Helianthus annuus* L.). Theoretical and Applied Genetics 125:921-932

5. Gong L, Hulke BS, Gulya TJ, Markell S, Qi LL 2012 Molecular tagging of a novel rust resistance gene R_{12} in sunflower (*Helianthus annuus* L.) Theoretical and Applied Genetics 126:93-99

6. Gong L, Gulya TJ, Markell S, Hulke BS, Qi LL 2012 Genetic mapping of rust resistance genes in confection sunflower line HA-R6 and oilseed line RHA 397. Theoretical and Applied Genetics (submitted on Oct. 12, 2012)

Websites

1. **Qi L.L**., Gulya T.J., Hulke B.S., Vick B.A. 2010. New Sunflower Rust Projects in the USDA Sunflower Research Unit. Presentation at the National Sunflower Association Research Forum, January 13-14, 2010, Fargo, ND. Available: http://www.sunflowernsa.com/research/research-workshop/ documents/Qi_Rust_10.pdf.

2. Gong L., Markell S., Vick B.A., Hulke B.S., Gulya T.J., **Qi L.L.** 2011. Progress on introduction of rust resistance genes into confection sunflower. Presentation at the National Sunflower Association Research Forum, January 12-13, 2011, Fargo, ND. Available: http://www.sunflowernsa.com/research/research-forum-presentations/2011/.

3. **Qi L.L.,** Gulya T.J., Hulke B.S., Vick B.A., Seiler G.J. 2012. Molecular mapping of the rust resistance genes in sunflower: results and prospects. Presentation at the National Sunflower Association Research Forum, January 11-12, 2012, Fargo, ND. Available: http://www.sunflowernsa.com/uploads/resources/621/molecular-mapping-of-the-rust---qi.pdf

4. Gong L., Markell S., Hulke B.S., Gulya T.J., **Qi L.L.** 2012. Progress on Rust Resistance Breeding of confection sunflowers and progress on sunflower SNP genetic mapping. Presentation at the National Sunflower Association Research Forum, January 11-12, 2012, Fargo, ND. Available: http://www.sunflowernsa.com/uploads/resources/622/progress-on-rust-resistance-breeding-of-confection-sunflowers---gong.pdf

5. Gong L., Markell S., Hulke B.S., Gulya T.J., **Qi L.L.** 2013. 2012 Breeding progress for rust resistance in confection sunflower. Presentation at the National Sunflower Association Research Forum, January 9-10, 2013, Fargo, ND.

PROJECT 2: PRODUCT AND MARKET DEVELOPMENT OF NORTH DAKOTA SPECIALTY CROP FOODS

Final Report

Project Summary

The purpose of this project was to develop food menu items utilizing North Dakota specialty crops, find North Dakota manufacturers wherever possible to manufacture these products, and develop a system within North Dakota to distribute the products to the marketplace. The market emphasis was on the school market, although the products produced could be made available to other institutions as well as the retail market.

This is an important project. It is estimated that approximately one fourth of North Dakota school children are overweight. Studies nationally show the rate is somewhere between 16% and 33%, depending on location. A variety of factors have led to this problem. Poor eating habits are certainly a major factor. This project was designed to find new, healthy food items for the school lunch program that could reverse this trend. Studies have shown that a child who is obese between the ages of ten and thirteen has an 80% chance of becoming an obese adult. The United States Department of Agriculture School Nutrition Program has recognized the seriousness of the situation and has made adjustments and new requirements to address this problem. Development of new menu items that are nutritious and meet USDA's new requirements can be a very positive factor.

This project seeks to introduce the following specialty crop products - dry beans, dry peas, lentils, chickpeas, sunflower and potatoes - into the school lunch program. These are all crops that are important to the North Dakota agriculture economy. It was determined early in the project to not pursue new potato products since a wide variety of those products were already prevalent in the school lunch program.

North Dakota has become a national leader in the production of pulse crops. Pulse crops are defined as an annual leguminous crop yielding from one to twelve grains or seeds of variable size, shape and color within a pod. Included in that definition are dry edible beans, dry peas, lentils, and chickpeas. As used in the USDA School Lunch Program, pulse crops can be classified as a vegetable or as a meat (protein) substitute on their menus. Pulses are particularly noted for their high protein and high fiber in addition to many valuable trace minerals. These characteristics make it a very desirable foodstuff.

North Dakota is a leader in the production of pulse crops. Here is a summary of the production in North Dakota as related to the rest of the United States.

Crop	Ranking amongst states	Percent of US Production
Pinto beans	1st	56%
Navy beans	1st	45%
Dry edible peas	1st	41%

Black beans	2nd	36%
Lentils	2nd	36%

A large portion of these products are exported to foreign counties. Obviously, creating a larger demand in the US market would benefit North Dakota producers.

North Dakota also leads the nation in the production of confectionary sunflower and produces over 25% of US production. Sunflower contains healthy unsaturated fats, protein and fiber, plus important nutrients like vitamin E, selenium, copper, zinc, folate, and iron.

While pulse crops are staple foods in other countries (e.g. dry beans in Mexico, peas in India), that is not the case in US food consumption. The challenge was to create products that meet the criteria of the school lunch program and encourage demand for those products.

Project Approach

Interviews with six North Dakota School Lunch Administrators (who represent 47% of all North Dakota school children in the School Lunch Program) were set up to determine what product lines amongst the specialty crops mentioned in the grant application would have the greatest acceptance in their market. These meetings were also used to brief them on the project, get a better understanding of the barriers and opportunities to reach the goals outlined, and seek their cooperation.

From those conversations, it was determined that there were essentially four primary criteria that needed to be met when developing products for the school lunch menu:

1-Meet USDA School Lunch nutrition requirements
2-Easy products to prepare and serve
3-Relatively low cost
4-Food that kids will want to eat

Additionally, interviews were set up to seek advice on how to proceed to meet the goals of the project. They included North Dakota State University's Northern Crops Institute, which has been a leader in the development of new food products, the USDA Human Nutrition Lab at Grand Forks, and officials at dining halls at both North Dakota State University and the University of North Dakota. Pulse Canada was consulted to learn of their latest research on development of food products from pulse crops.

Meetings were held with other interested groups in the project including the Northern Pulse Growers Association, National Sunflower Association, and Northern Plains Potato Growers Association to get their input.

During the earlier portion of the grant process, scores of recipes were reviewed for possible inclusion as potential products. Products that did not appear to meet the criteria for the school lunch market were set on the back burner.

Northern Crops Institute at North Dakota State University was contracted with to develop some new products. The two North Dakota universities were consulted on recipes they had developed for their student lunch program.

A detailed list of the potential products with ingredients, manufacturing process, and nutritional facts was developed. It was determined that a potential market existed in the schools for nutritious snack products for the school canteen and a la carte and for snacks for students while traveling by bus to out of town extra-curricular activities or field trips.

In May, 2012 taste testing began on six products – bread stick, sunflower grissini (bread stick), trail mix, pulse burger, garbanzo bean slider, and a black bean burger slider. Continual product development and taste testing continued throughout the grant period. A listing of the nineteen products that were taste tested is listed in the addendum with their rating by the students. A score card was developed for students to evaluate the products based on a 1-2-3 score. Score 1 meant they didn't like the product, score 2 meant they liked the product somewhat, and score 3 meant they liked the product a lot. Scores were calculated and an average score was obtained for each product.

Taste testing was done at the annual North Dakota School Lunch Administrators conference in June, 2012 on ten products. That was not originally anticipated in the original project plan, but it was determined that it would be a good way to get a feel for new products that had been developed but couldn't be taste tested in the schools until fall when school resumed. They included North Dakota waffle, sunflower kernels, navy bean pasta, black bean chip, pinto bean chip, fiesta salsa, split pea snack, hummus, and the bread stick and trail mix that had been taste tested earlier in the schools. All of them scored well except the hummus. A listing of all the products tested with the results, conclusions and recommendations can be found in Addendum A.

Taste testing was resumed in the fall of 2012. One of the stated targets in the grant application was to expose 5% of the children in the North Dakota school lunch system to new recipes created from this project during the 2012-13 year. There is a participation rate of 78,064 students in the North Dakota School Lunch Program. 7,433 samples were taste tested during the year, which is an exposure rate of 9.53%. This was due to great cooperation by local School Lunch Administrators. Excellent support was also given by the North Dakota Department of Public Instruction Food Nutrition staff in the early phases of this project.

One hundred forty-five Pride of Dakota food companies were contacted to determine if they were interested in manufacturing or distributing these products. Face to face meetings were held with 27 manufacturers or distributors. Some manufacturers expressed concern when they found out that the recipes would be public information and they would not have exclusive access. They were reminded that they could take these recipes, make whatever appropriate changes they desired, and, thus, create their own exclusive product line.

Goals and Outcomes Achieved

The activities that were completed to achieve the performance goals and measurable outcomes have been detailed in the Project Approach section of this report. In summary, it required determining what kind of products might have market potential through consultation with school lunch officials and others, developing the recipes for those products, taste testing the products in a school setting, and taking these results to potential manufacturers and distributors to place them in the marketplace.

The expected outcomes of this project included:

- **Develop 10 processed specialty crop products for the school marketplace.**
  This goal has been achieved. Nineteen specific products were developed and tested in the school system. The nineteen products are:

  North Dakota waffle, whole grain bread stick, navy bean pasta, fiesta pasta sauce, sunflower grissini (breadstick), chickpea crouton, hummus, nacho bean and rice chip, black bean chipotle BBQ chips, hummus chip, black bean chip, pinto bean & flax chip, pinto bean & flax cheddar cheese chip, split yellow pea snack, sunflower kernels, trail mix, pulse burger, black bean burger slider, and garbanzo bean slider.

  The nutrition facts, results of taste testing, and the status of each product is included in Addendum A.

- **Find North Dakota food manufacturers and processors (wherever possible) to make those products.**
  Food manufacturers were found for thirteen of the nineteen products. For the six remaining products, no interest has yet been found. Some of these products may need to have recipe revisions to make them more saleable. Due-diligence on market potential in the school lunch program needs to transpire now that taste testing results have been completed. To these companies who have not been in the school market sector before, they must evaluate whether this market fits into their long term overall company marketing strategy.

- **Develop an economical and efficient distribution system to market the products to schools.**
  North Dakota schools are supplied primarily by three large distributing companies. Having these companies provide the distribution of the products would be the most economical and efficient distribution system. However, they are only interested in carrying products that have strong demand. Creating demand for a new product in the market takes time. Thus, manufacturing companies must struggle with distributing new products themselves until they reach a high enough volume that it is to their advantage as well as the large distributor's to take on the product.

  One of the additional problems for the manufacturer is that schools are reluctant to add new vendors. School Lunch Administrators like the convenience of dealing with a very

small handful of distributors. This is another barrier that the manufacturers will have to overcome as they do their own distribution initially.

While the long term goal is to develop an economical and efficient distribution system, the first phase is for the manufacturing companies to develop the market sufficiently so these distributing companies have an interest in carrying their products. Reaching this goal will require the manufacturer to provide a good product and great service as they develop their customer base. Since the goal of developing the new products and finding manufacturers is just getting completed, the goal of developing an economical and efficient distribution system was not possible to complete in the short time frame of this grant.

Beneficiaries

The following groups that benefited immediately from the completion of this project included school lunch administrators, food manufacturers, commodity groups, and a cross section of students.

One hundred fifty school lunch administrators were exposed directly to ten of the new products being developed. They are continually looking for new products and new ideas to meet the nutritional requirements for the students they serve. This project gave them an opportunity to examine potential products that they could serve in their school system.

One hundred forty-five food companies were given the opportunity to look at new products that they might consider in their product line. While many of them currently stated they were not interested in expanding at this time, the seed was planted about the potential of doing something in the future.

The commodity groups (Northarvest Bean Growers Association, Northern Pulse Growers Association, and National Sunflower Association) now have research data on some of the products that their members produce. This research will be important as they look at future promotion and research projects to grow their industry.

A cross section of North Dakota students had the opportunity to provide input to their school leaders on the kind of products they might want in their school lunch menu.

The long term beneficiaries of this project will be:

- **The North Dakota farmer through increased utilization of North Dakota specialty crops that they produce**.
  There are approximately 1,700 dry edible bean producers, 2,100 dry edible pea producers, and 1,400 confectionary sunflower producers in North Dakota. The long term advantage to them will result when some of these products are marketed nationally to a much larger market. If an additional ½ cup of pulse crop or sunflower products were served in the United States School Lunch

Program each week that would result in 418 million pounds of increased production.

- **The children of the state by creating good, nutritious food and excellent eating habits.**

  There is no question that the products created and marketed as a result of this project will have a long term benefit to the children of the state who utilize them in the school lunch program. Good eating habits acquired as a youth serve as a strong base for life-long good eating habits. Time will tell how many of these 78,064 students will have access to these products.
- **The development of a larger food manufacturing industry in North Dakota.**

  North Dakota is noted for its tremendous production of farm commodities; it leads the country in the production of approximately a dozen different commodities. The state is much less noted for adding value to these commodities through food processing and manufacturing. There is no way at this time to quantify what the results of this project will have on long term food manufacturing in the state, but it certainly will add to the base of food manufacturing currently being done.

Lessons Learned

The target of finding manufacturers and distributors was not an easy task. There is a reluctance of manufacturers to want to start a new product line. Many companies now have their plant at full capacity and with a booming North Dakota economy, are finding it difficult to find qualified laborers. Some other issues include the inability to full access the potential size and profitability of the proposed products.

There are several problems that have surfaced that were unexpected. New USDA Federal Food and Nutrition Program guidelines were not announced until January 2012, to be effective starting in September of 2012. The School Lunch Administrators were under great pressure to comply with the new rules. This resulted in School Lunch Administrators being so busy that they needed to concentrate on meeting the new standards and, thus, not as enthused to look at new products until they felt they had control over the new mandates. This prevented taste testing getting done in September as originally planned. That meant delaying meaningful discussions with food manufacturers without taste testing data.

The USDA Child Nutrition Program also came out with a policy that said:

"We require that in order to be creditable, at least 1/8 cup of an item must be served in an identifiable form. With the advent of the "stealth nutrition" concept, we are hearing more interest in products which contain vegetables or other items that are essentially "hidden" in other products (ie, bread made with bean powder). While we certainly want to encourage the service of healthier products, this approach again not consistent with the DGA emphasis on whole foods- nor our proposed rule, which encourages schools to serve foods in a manner that helps children learn how to make nutritious choices."

When surveying the school lunch administrators, they indicated that dry beans and dry peas are generally not popular with the students. The policy against "stealth nutrition" that came from USDA makes it even more difficult to develop new products.

School lunch administrators have also indicated that they would like the products that are developed to be delivered through the existing three large distributing companies that serve most of the schools in North Dakota. This is difficult to do in a short time, since most of these distributors won't take on products until there is a history of good sales. Many small North Dakota manufacturers have difficulty distributing or are not interested in distribution.

It was also learned that School Lunch Administrators generally plan their menus in May for the entire next school year. They also book a year ahead of time with their distributors. Thus, it is not possible to quickly move new products into the system.

The biggest lesson learned is that it is a difficult and, sometimes, expensive process to develop new food products and successfully market them. More food products fail in the market place than are successful. However, the marketplace, particularly the school lunch market, is looking for new, healthy products to meet the new nutritional requirements in their system. This is an encouraging sign.

Contact

Tim Courneya, Executive Vice President
Northarvest Bean Growers Association (NBGA)
Telephone: 218-334-6351
Email: nhbean@loretel.net
Website: www.northarvestbean.org

Additional Information

Attached:
Addendum A- Listing of products, taste testing results and nutrition facts

Addendum A

Nineteen different products were developed and taste tested for this project. These products are listed below with nutrition facts and general comments.

North Dakota Waffle

This product was developed to be sold either as a dry waffle mix or as a frozen product. Only water and canola oil needs to be added to the dry mix before cooking. The mix can be prepared by a manufacturer, baked, and then sold as a frozen product. The frozen product can be popped into a toaster or oven to be heated and then served. Both the dry mix and the frozen product have potential in the retail market. The frozen product has greater potential in the school lunch system than the dry mix because of the *heat and eat* cooking method now employed by most schools because of labor requirements.

The unique feature is that this product has 6 specialty crop flours in the formula which include 9 different flours. This formula contains more protein and fiber than is found in conventional pancake and waffle mixes. It scored a 2.23 out of a possible 3 when tested with 401 students. At the ND School Lunch Administrators convention it scored 2.77. Two manufacturers have indicated an interest in developing the dry mix product.

Nutrition Facts

Serving Size: 1/4 cup mix (40g)
Servings Per Container: about 20

Amount Per Serving	
Calories 130	Calories From Fat 0
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 290mg	**12%**
Total Carbohydrate 28g	**9%**
Dietary Fiber 3g	**11%**
Sugars 8g	
Protein 6g	

Vitamin A 2%	• Vitamin C 0%
Calcium 15%	• Iron 6%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

INGREDIENTS: WHOLE WHEAT FLOUR (HIGH PROTEIN SPRING WHEAT); ALL-PURPOSE FLOUR (WHEAT FLOUR, MALTED BARLEY FLOUR, NIACIN, IRON, THIAMINE, RIBOFLAVIN, FOLIC ACID); NONFAT DRY MILK, VITAMIN A PALMITATE AND VITAMIN D3; GRANULATED SUGAR; EGG REPLACER (POTATO STARCH, TAPIOCA FLOUR, CALCIUM LACTATE (FOR LEAVENING) CALCIUM CARBONATE (FOR LEAVENING), CITRIC ACID (FOR LEAVENING), CELLULOSE GUM MODIFIED CELLULOSE); ORGANIC YELLOW SPLIT PEA FLOUR; ORGANIC GREEN SPLIT PEA FLOUR; ORGANIC LENTIL FLOUR; ORGANIC GARBANZO BEAN FLOUR; ORGANIC SMALL WHITE BEAN FLOUR; PINTO BEAN FLOUR; POTATO FLOUR; ORGANIC BARLEY FLOUR; BAKING SODA (BAKING SODA (FOR LEAVENING), CORNSTARCH (MAINTAINS LEAVENING), SODIUM ALUMINUM SULFATE(FOR LEAVENING), CALCIUM SULFATE (MAINTAINS LEAVENING), MONOCALCIUM PHOSPHATE (FOR LEAVENING), BAKING SODA; SALT; VANILLA EXTRACT; ALMOND EXTRACT. CONTAINS WHEAT, MILK.

Whole Grain Bread Stick

This product was developed at the Northern Crop Institute at North Dakota State University. It has a 51% whole grain flour which is being required in the school lunch program. It is fortified with yellow pea flour to increase protein and fiber. This product scored a 2.23 out of a possible 3 when tested with 117 students. At the ND School Lunch Administrators convention it scored 2.38. However no manufacturers have indicated an interest in developing this product at this time. It is certainly a viable product that scored well. It may be more suited for the specialty food market than the school lunch program.

Nutrition Facts

Serving Size (50g)
Servings Per Container

Amount Per Serving

Calories 110	Calories from Fat 10
	% Daily Value*
Total Fat 1g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 21g	**7%**
Dietary Fiber 4g	**16%**
Sugars 2g	
Protein 5g	

Vitamin A 0% • Vitamin C 0%

Calcium 2% • Iron 8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: Whole wheat flour, yellow pea flour, water, sugar. gluten, salt, canola oil, yeast, vinegar, softase, Italian seasoning, SSL, Parmesan cheese.

Navy Bean Pasta

This product was developed at the Northern Crops Institute at North Dakota State University. It has a 51% whole grain flour which is being required in the school lunch program. It is fortified with 33% navy bean flour to increase protein and fiber. Its protein level is about 25% over traditional pasta and fiber is increased by 100% over traditional pasta. There is no noticeable difference in taste from traditional pasta. This product scored a 2.14 out of a possible 3 when tested with 1,466 students. At the ND School Lunch Administrators convention it scored 2.63. Samples of the product have been sent to four North Dakota pasta processors. Adding an additional product line is a big decision for pasta companies to make. It may be some time before a decision is forthcoming.

Nutrition Facts

Serving Size (56g)
Servings Per Container

Amount Per Serving	
Calories 140	Calories from Fat 5
	% Daily Value*
Total Fat 1g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 28g	**9%**
Dietary Fiber 6g	**24%**
Sugars 1g	
Protein 7g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 10%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: Whole grain durum flour, navy bean flour, semolina.

Fiesta Pasta Sauce Dry Mix

This product was developed from a recipe created by the Northarvest Bean Growers Association. Because of the widespread use of *heat and eat* cooking at schools, the recipe was adjusted to use dehydrated pinto beans and other dry products. All that needs to be done is to add water and canola oil, which rehydrates the dry ingredients, heat, and serve. This product scored a 2.14 out of a possible 3 when tested with 123 students. Nothing was served with the sauce when it was tested. There was a general feeling that the score would have been higher had a pasta been included. However, it was felt that the only way to evaluate the product was to taste test it by itself. Two manufacturers have expressed an interest in developing the product.

Nutrition Facts

Serving Size (37g)
Servings Per Container 16

Amount Per Serving

Calories 160	Calories from Fat 45
	%Daily Value*
Total Fat 5g	8%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 220mg	9%
Total Carbohydrate 18g	6%
Dietary Fiber 6g	22%
Sugars 1g	
Protein 9g	

Vitamin A 35% • Vitamin C 20%

Calcium 6% • Iron 10%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carb		300g	375g
Dietary Fiber		25g	30g

Ingredients: Dehydrated pinto bean, canola oil, dry tomato basil sauce mix, minced try garlic, minced dry onion, minced dry tomato flakes, dry green peppers, food starch, salt, maltodextrin, spice, paprika, beet powder, citric acid.

Sunflower Grissini (bread stick)

This product was developed by the Northern Crop Institute at North Dakota State University. It has a 51% whole grain flour which is being required in the school lunch program. It is fortified with pea flour and sunflower seeds. The product is tube shaped, being about ½ inch in diameter and 10 inches long. This product scored a 2.09 out of a possible 3 when tested with 115 students. While the taste was satisfactory, the stick was dense and thus somewhat hard. It was not possible to determine if it was the ingredients or the baking process that caused this problem. A bid of $2,000 was given by a consultant to try and fix the problem. Because of limited funds, it was decided not to pursue that with this grant. The shape of the product is attractive as a finger food for young people.

Nutrition Facts

Serving Size (20g)
Servings Per Container

Amount Per Serving

Calories 80	Calories from Fat 20
	% Daily Value*
Total Fat 2.5g	4%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 5mg	2%
Sodium 125mg	5%
Total Carbohydrate 11g	4%
Dietary Fiber 2g	8%
Sugars 3g	
Protein 4g	

Vitamin A 0%	• Vitamin C 0%
Calcium 6%	• Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: Whole wheat flour, pre-gelled pea flour, milk, olive oil, chopped sunflower seeds, salt, honey, instant dry yeast, egg wash.

Chickpea croutons

This product was developed as the result of a suggestion by a school lunch administrator. It was designed as a nutritious replacement for bread croutons at salad bars. The sample that was created contained a variance in the crunchiness of the product. As a result, it scored a 1.70 when tested with 121 students. The Northern Crop Institute has just developed a chickpea-corn product that is puffed and very favorable. That may be a better product to market than this roasted chickpea. A manufacturer has been found that can manufacture the product.

Nutrition Facts

Serving Size 28g

Amount Per Serving	
Calories 80	Calories from Fat 20
	% Daily Values*
Total Fat 2g	**3%**
Saturated Fat 0.05g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 95mg	**4%**
Total Carbohydrate 19g	**6%**
Dietary Fiber 9g	**36%**
Sugars 0.67g	
Protein 8g	**16%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Roasted chickpeas, canola oil, sea salt, garlic powder.

Hummus

Hummus is a product that is made from chickpeas. It is a fast growing product in the United States. It is gaining popularity amongst college students. However, it scored near the bottom of the nineteen products that were tested. It scored a 1.66 when tested on 447 students. It should be noted that about 25% of the students liked it a lot or somewhat. There is a potential market if you could target that group. However, as a product that could be placed on the school lunch menu as a staple product like potatoes, it has limited possibilities. Numerous manufacturers can be found to manufacture the product, but with these results, little interest would be found to develop the school market.

Nutrition Facts

Serving Size 50 grams

Amount Per Serving	
Calories 63	Calories from Fat 27
	% Daily Values*
Total Fat 3g	**5%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 120mg	**5%**
Total Carbohydrate 3g	**1%**
Dietary Fiber 1g	**4%**
Sugars 2g	
Protein 6g	**12%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Chickpeas, seasame paste, water, sea salt, natural spices, citric acid.

Pulse Chips

When meeting with school lunch administrators at the beginning of this project, it was suggested that a potential market existed in the schools for nutritious snack products for the school canteen and a la carte as well as for snacks for students while traveling by bus to out of town extra-curricular activities or field trips. These products would not necessarily be reimbursable through the federal school lunch program, but it would be an effort to increase the quality of snacks that students are choosing at school.

Students eat a lot of chip products. Pulses provide a much better nutritious product than traditional chip products. Thus, six different chip products that have not been in the school program were tested. Below are the results of the taste testing and the nutritional label for them:

Ratings of various chips:	**# of students**	**Test score**
Nacho Bean and Rice Chip	123	2.45
Black Bean Chipotle BBQ Chips	704	1.97
Hummus Chip	378	1.95
Black Bean Chip	630	1.85
Pinto Bean Chips & Flax Chips	778	1.77
Pinto Bean Cheddar Cheese Chips	354	1.59

Black Bean Chip with Chipotle BBQ

Nutrition Facts

Serving Size 28g

Amount Per Serving	
Calories 140	Calories from Fat 60
	% Daily Values*
Total Fat 7g	**11%**
Saturated Fat 0.5g	**3%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Potassium 260mg	**7%**
Sodium 150mg	**6%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 5g	**20%**
Sugars 0g	
Protein 4g	**8%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Whole black beans, whole grain rice (long rain brown and/or white), pure sunflower oil, cane sugar, sea salt, tomato powder, onion powder, chipotle pepper powder, spices, garlic powder, paprika, natural smoke flavor, corn free citric acid, guar bean gum.

Black Bean Chip

Nutrition Facts

Serving Size 28g

Amount Per Serving	
Calories 140	Calories from Fat 60
	% Daily Values*
Total Fat 7g	**11%**
Saturated Fat 0.5g	**3%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Potassium 260mg	**7%**
Sodium 150mg	**6%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 5g	**20%**
Sugars 0g	
Protein 4g	**8%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Whole black beans, whole grain rice (brown and/or long grain white), pure sunflower oil, guar bean gum, sea salt

Pinto bean and flax chips

Nutrition Facts	
Serving Size 28g	
Amount Per Serving	
Calories 150	Calories from Fat 70
	% Daily Values*
Total Fat 8g	**12%**
Saturated Fat 0.5g	**3%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Potassium 240mg	**7%**
Sodium 55mg	**2%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 5g	**20%**
Sugars 0g	
Protein 4g	**8%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Whole pinto beans, whole brown flaxseeds, whole grain rice (brown and/or long grain white), pure sunflower oil, guar bean gum, sea salt.

Pinto Bean and Flax Chips with Cheddar Cheese

Nutrition Facts	
Serving Size 28g	
Amount Per Serving	
Calories 140	Calories from Fat 70
	% Daily Values*
Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Potassium 250mg	**7%**
Sodium 140mg	**6%**
Total Carbohydrate 14g	**5%**
Dietary Fiber 5g	**20%**
Sugars 0g	
Protein 4g	**8%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Whole pinto beans, whole brown flaxseeds, whole grain rice (long grain brown

and/or white), pure sunflower oil, hormone free cheddar cheese blend [cheddar cheese, (pasteurized milk, cheese cultures, salt, enzymes), whey, buttermilk, annatto], sea salt, onion powder, garlic powder, spices, hormone free lactic acid, tomato powder, corn free citric acid, guar bean gum.

Hummus Chip

Nutrition Facts	
Serving Size 28g	
Amount Per Serving	
Calories 120	Calories from Fat 40
	% Daily Values*
Total Fat 4.5g	**7%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 310mg	**13%**
Total Carbohydrate 17g	**6%**
Dietary Fiber 1g	**4%**
Sugars 2g	
Protein 3g	**6%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Garbanzo flour, sunflower oil, starch (potato, corn), defatted soy flour, maltodextrin, olive oil, spices, chili pepper, roasted red bell pepper, salt, garlic, and onion, natural flavors, including cream, oleoresin paprika, citric acid, parsley.

Bean and Rice Chip

Nutrition Facts	
Serving Size 28g	
Amount Per Serving	
Calories 120	Calories from Fat 40
	% Daily Values*
Total Fat 4.5g	**7%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 310mg	**13%**
Total Carbohydrate 17g	**6%**
Dietary Fiber 1g	**4%**
Sugars 2g	
Protein 3g	**6%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Black beans, navy beans, long grain rice, high oleic safflower oil, sunflower oil. FLAVORING: Potato malto-dextrin, salt, tomato powder, cane sugar (vegan), onion powder, yeast extract, paprika, green bell pepper powder, red bell pepper powder, natural non-dairy flavor, extractives of annato, lactic acid, calcium lactate, grill flavor (from sunflower oil), not more than 2% silicon dioxide to prevent caking.

Other snacks

In addition to chips as a high protein snack, three other snack products were developed and tested. The products included a yellow pea snack, a trail mix with four specialty crops, and sunflower kernels. These snacks could be served separately or as part of a snack pack with the chips as a high protein energy boosting snack.

Yellow Pea Snack

This is a product with a very simple formula. Yellow peas are high in protein and fiber and can be tasty with only a small amount of salt. This product scored a 2.35 out of a possible 3 when

tested with 119 students. At the ND School Lunch Administrators convention it scored 2.36. Manufacturers are available to produce this product.

.

Nutrition Facts

Serving Size 28 grams

Amount Per Serving	
Calories 112	Calories from Fat 20
	% Daily Values*
Total Fat 2g	**3%**
Saturated Fat 0.2g	**1%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 111mg	**5%**
Total Carbohydrate 17g	**6%**
Dietary Fiber 7g	**28%**
Sugars 2.3g	
Protein 7g	**14%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Roasted split yellow peas, sunflower oil, salt, pepper.

Sunflower Kernels

This is a nutritious product that is popular with young people, but has not found its way into the school lunch system. It scored a 2.29 when tested with 355 students. It tested a 2.77 score at the School Lunch Administrators convention. Manufacturers are available to produce the product.

Nutrition Facts

Serving Size 28 grams

Amount Per Serving	
Calories 160	Calories from Fat 120
	% Daily Values*
Total Fat 13g	**20%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Potassium 230mg	**7%**
Sodium 210mg	**9%**
Total Carbohydrate 7g	**2%**
Dietary Fiber 3g	**12%**
Sugars 1g	
Protein 5g	**10%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Sunflower kernels, sea salt, sugar, cornstarch, contains 1% or less of the following: monosodium glutamate, maltodextrin, smoked torula yeast, dried corn syrup, spice, garlic powder, onion powder.

Trail Mix

This product was developed by the Northern Crop Institute at North Dakota State University. It incorporates green peas, yellow peas and lentils in equal proportions. Dried cranberries and mini chocolate chips are added for flavor. This product scored a 1.87 out of a possible 3 when tested with 982 students. It scored 2.63 with the North Dakota School Lunch Administrators. Student comments included a request for more chocolate chips in the recipe. Based on the nutritional facts, this could be increased and still be a very nutritious product. Food manufacturers are available to produce the product.

Nutrition Facts

Serving Size (30g)
Servings Per Container

Amount Per Serving

Calories 130	Calories from Fat 40
	% Daily Value*
Total Fat 4.5g	**7%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 150mg	**6%**
Total Carbohydrate 17g	**6%**
Dietary Fiber 5g	**20%**
Sugars 7g	
Protein 5g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 6%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: Roasted red lentils, roasted split yellow peas, roasted split green peas, roasted sunflower seeds, dried cranberries, mini semi-sweet chocolate chips, canola oil, sea salt.

Meat Substitutes

Three different meat substitutes were taste tested for the school lunch program. A pulse burger was developed by the Northern Crop Institute at North Dakota State University. The ingredients included yellow pea, red lentil and green peas. A black bean slider and a garbanzo bean slider were tested from recipes obtained from the University of North Dakota Food Service Division. The testing was done just with the product itself, without adding condiments, which is generally added when serving a beef hamburger. The pulse burger scored the best of the three products, but none of them scored high. These tests were done early on in the grant period and it was decided to move on to other potential products. With some enhancements to the recipe to increase taste, these products could have a place in the school lunch program. Attempts to find a food processor to take on this task were unsuccessful. The University of North Dakota does have the authority to become a manufacturer and marketer of the product, but with the taste test results, that will not happen.

Here are the scores and the nutrition labels for the three products:

Ratings of various meat substitutes: # of students Test score

Pulse burger	89	1.78
Black bean burger slider	65	1.71
Garbanzo bean slider	66	1.44

Pulse Burger

Nutrition Facts

Serving Size (40g)
Servings Per Container

Amount Per Serving

Calories 120 Calories from Fat 15

	% Daily Value*
Total Fat 1.5g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 190mg	**8%**
Total Carbohydrate 20g	**7%**
Dietary Fiber 7g	**28%**
Sugars 2g	
Protein 7g	

Vitamin A 0% • Vitamin C 2%
Calcium 2% • Iron 6%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: Cooked split yellow peas, cooked decorticated red lentils, cooked split green peas, canned black beans, all-purpose flour, tapioca flour, xanthan gum, vital wheat gluten, canola oil, garlic powder, dehydrated onion, sea salt, sugar, Lowry's seasoning, Italian seasoning, cider vinegar, corn starch.

Black Bean Burger Slider

Nutrition Facts

Serving Size 3 oz.

Amount Per Serving	
Calories 201	Calories from Fat 14
	% Daily Values*
Total Fat 1.5g	**2%**
Saturated Fat 0.1g	**1%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 255.5mg	**11%**
Total Carbohydrate 39g	**13%**
Dietary Fiber 6.2g	**25%**
Sugars 3.7g	
Protein 8.7g	**17%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Black beans (soaked black beans, water, salt calcium chloride), water, high fructose corn syrup, yeast, vegetable oil. Contains 2% or less of each of the following: vital wheat gluten, salt, yeast nutrient (ammonium sulphate), dough conditioners, (mono diglycerides, sodium stearoyl lactyite, ascorbic acid, monocalcium photsphate), calcium sulfate, enzymes, calcium propionate (mold inhibitor), Kellogg's corn flakes (corn syrup, niacinamide, sodium ascorate, ascorbic acid, iron, pyridoxine hydrochloride, riboflavin, vitamin A palmitate, thiamin, hydrochloride, folic acid, vitamin D, red onions, picante sauce (tomato puree, water, tomato paste), fresh jalapeno peppers, fresh onions, distilled vinegar, salt, dehydrated onions, dehydrated garlic, ground cumin, tabasco sauce (peppers, salt, vinegar).

Garbanzo Bean Slider

Nutrition Facts	
Serving Size 3 oz.	
Amount Per Serving	
Calories 199	Calories from Fat 38
	% Daily Values*
Total Fat 4.2g	**6%**
Saturated Fat 0.8g	**4%**
Trans Fat 0g	
Cholesterol 0.7mg	**0%**
Sodium 147.6mg	**6%**
Total Carbohydrate 32.3g	**11%**
Dietary Fiber 7.7g	**31%**
Sugars 5.5g	
Protein 9g	**18%**

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Garbanzo beans (soaked garbanzo beans, water, salt, disodium EDTA, sodium bisulfite), diced yellow onions, homestyle seasoned croutons (enriched wheat flour (flour, malted barley flour, niacin, reduced iron, thiamine mononitrate, riboflavin, folic acid), partially hydrogenated soybean oil, high fructose corn syrup, whey, salt. Contains 2% or less of each: yeast, cornstarch, Romano cheese (cultured part skim milk, salt, enzymes), red pepper, disodium phosphate), Hidden Valley FF Ranch (water, corn syrup, maltodextrin, sugar, modified food starch, buttermilk, salt, less than 2% of vinegar, garlic puree, onion puree, dried garlic, dried onion, spice, sour cream (cream, nonfat milk, cultures), xanthan gum, soy lecithin, soybean oil, monoglycerides, natural flavors (soy), artificial color, monosodium glutamate, lactic acid, phosphoric acid, disodium phosphate, with potassium sorbate, sodium benzoate, TBHQ and calcium disodium EDTA as preservatives, alpha tocopherol (vitamin E), chopped garlic.

Fiesta Salsa

This product is from a recipe created by a school lunch administrator in North Dakota. This salsa can be used as a vegetable or as a meat substitute in the school lunch program. The product was considered as a possible part of a three product snack pack that would include chips and one of the three snack items (yellow pea snack, sunflower kernels or trail mix). However, once this salsa is made it must be refrigerated unless it is manufactured into a sealed container. The product was taste tested at the North Dakota School Lunch Administrators Conference and scored a very high 2.54. Efforts were made to find a manufacturer who could prepare this product economically in a small sealed container, but those efforts were unsuccessful. If that processing challenge could be overcome, this would have great potential.

It is hoped, by including this recipe in this report, that a food manufacturer might see the potential of this product and attempt to overcome the obstacles.

Recipe for 200 ½ cup servings:

4 #10 cans black beans
4# 10 cans pinto beans
4#10 cans corn, drained
5# bag red onion
9.5# green pepper
10# red pepper
9.5# celery
3 cups vegetable oil
1 quart, 3 cups granulated sugar
56 ounces apple cider vinegar
2 ounces salt
2 ounces black pepper, ground

Method:
Drain, rinse beans. Dice onions, green and red peppers, and celery. Combine diced vegetable with beans and corn. Combine oil, sugar, vinegar, salt and pepper in a separate container. Mix with other ingredients. Refrigerate overnight.

PROJECT 3: INCREASING FRUIT AND VEGETABLE PRODUCTION TO SUPPLY ND FARM AND SCHOOL PROGRAMS

Final Report

Project Summary

Interest in locally produced specialty crops (produce and fruits) has grown substantially in North Dakota in the past 6 years based on the growing number of CSAs (Community Supported Agriculture) and farmers markets.

North Dakota became a Farm to School recognized state in 2009. Education about farms and farmers is also an integral part of the equation.

The need for more data and communication between food service and farmers exists throughout the state. North Dakota has not collected any data on farm to school since 2009 making it difficult to gauge the growth of the sale of specialty crops in the state as well as barriers to be addressed between the farmer and institutions.

The purpose of this project was to (1) collect baseline data from schools and producers; (2) increase the awareness that it is okay to buy produce from farmers and (3) reduce the barriers to procurement by networking farmers and food service through education and roundtable discussion.

It was our desire to increase the use of specialty crops by 15% in schools; increase the number of schools participating in farm to school; and increase the number of producers willing to work with schools.

This project was birthed from the work of the North Dakota Department of Agriculture's Local Foods initiative funded by a Specialty Crop Block Grant in 2009.

Project Approach

A serious lack of baseline data showed the need for surveys and data collection from both schools and producers. From that data several trainings were held to fill in the knowledge gaps between producers and school food service personnel to effectively reduce the barriers to more schools doing Farm to School activities.
A steering committee was formed to guide the process. Members include:

- Don Bajumpaa -- Wilkin Soil and Water Conservation, Breckenridge, Minn. And Hunger Free ND Garden feeding program donor, Wahpeton, ND.
- Lori Martin, chef and producer, Bismarck, ND.
- Lana Feeley – Family and Consumer Science teacher at Davies High School, Fargo, ND.
- Rachel Brazil – gardener, New Rockford, ND.
- Tracie Thompson – Thompson Farms, Antler, ND.

- Holly Mawby – Executive Director of the Entrepreneurial Center for Horticulture at Dakota College in Bottineau, ND.
- Dana Pritschet – Local Foods Marketing Specialist for the North Dakota Department of Agriculture, Bismarck, ND.
- Karri Stroh – Northern Plains Sustainable Agriculture executive director and producer, Tappen, ND
- Deb Egeland – School Nutrition Programs Manager for the North Dakota Department of Public Instruction, Bismarck, ND.
- Daryl Traeger – Market Manager Twin Towns Gardeners' Market, Wahpeton, ND
- Scott and Gwen Dubord – producers for Jamestown Public School District, Jamestown, ND.

Two surveys were held in 2011-2012 with all schools in the state and as many producers as we could encourage to complete the survey for growers.

From those surveys, trainings for producers were held. Training sessions were held for food service personnel as well. Partners including local health units, the state departments of public instruction, agriculture and food and lodging division were invited to attend any and all trainings.

A directory was created and distributed with contact information for schools and producers.

After training sessions and workshops a second set of surveys were distributed to producers and schools in 2012-2013 for comparison.

FARRMS held two farm food safety trainings sessions on April 20 and April 27, 2012. There were 21 participants between the two sessions.

A follow-up field day was held August, 9, 2012 with 14 participants.

An October networking session with food service and farmers was held in Medina. The weather was a bit dicey that day but we had about 12 folks attend this session.

Farm food safety training focuses only on handling; harvesting, cooling and cleanliness of specialty crops and farm workers who work with the produce.

The focus of these trainings is solely specialty crops. To ensure the use of funds solely enhances the competitiveness of specialty crops, farm to school activities as marketed by FARRMS staff are documented on hourly time cards as only partial duties. Non-specialty crop activities are matched by donors and/or additional non specialty crop grants and questions about non-specialty crop products are referred to the Department of Agriculture or the Department of Public Instruction.

Four webinars were held in December:
Reconnecting Farms to Schools – 20 participants
What is farm food safety training all about? – 16 participants
How to conduct an Iron Chef event – 15 participants
How food hubs or cooperatives can help sellers and buyers – 22 participants

TOTAL: 73 via online classroom.

Goals and Outcomes Achieved

Using the work plan submitted in the initial proposal, the following tasks have been accomplished and the outcomes were recorded through January 2013:

1. **Recruit and assemble a statewide steering committee to provide direction throughout the project.**
    a. The farm to school steering committee consists of the following people and/or partners
        i. Don Bajumpaa -- Wilkin Soil and Water Conservation, Breckenridge, Minn. And Hunger Free ND Garden feeding program donor, Wahpeton, ND.
        ii. Lori Martin, chef and producer, Bismarck, ND.
        iii. Lana Feeley – Family and Consumer Science teacher at Davies High School, Fargo, ND.
        iv. Rachel Brazil – gardener, New Rockford, ND.
        v. Tracie Thompson – Thompson Farms, Antler, ND.
        vi. Holly Mawby – Executive Director of the Entrepreneurial Center for Horticulture at Dakota College in Bottineau, ND.
        vii. Dana Pritschet – Local Foods Marketing Specialist for the North Dakota Department of Agriculture, Bismarck, ND.
        viii. Karri Stroh – Northern Plains Sustainable Agriculture executive director and producer, Tappen, ND
        ix. Deb Egeland – School Nutrition Programs Manager for the North Dakota Department of Public Instruction, Bismarck, ND.
        x. Daryl Traeger – Market Manager Twin Towns Gardeners' Market, Wahpeton, ND
        xi. Scott and Gwen Dubord – producers for Jamestown Public School District, Jamestown, ND.

OUTCOME: It was the decision of the steering committee that was formed in November of 2011 that after several conference calls it would be easier to use email as a form of ongoing and convenient communication. The committee reviewed documents and surveys and advised coordinator (including proof reading and beta testing surveys). Using email decreased the original communications cost and was used for a second postal mailing to the schools and additional training sessions. Contact with steering committee was then permissible on an ongoing and weekly basis. We did hold several conference calls and GoToMeeting sessions. The current committee reviewed and compared the surveys in January of 2013. See item number 8 below for evaluation comments made on second survey.

2. **Develop and conduct a survey of school food service professionals to document baseline usage of ND fruits and vegetables (specialty crops were listed specifically in this survey) and identify obstacles for increasing use.**
    a. The food service farm to school survey was created and adopted for use with permission from the National Farm to School Missouri State Lead Bill McKelvey.

b. The comprehensive survey was distributed on Dec. 8, 2011. Of the 216 schools/school districts, 97 completed the survey. Partial surveys were included in the final report; less than 5 "no response" surveys were discarded.

3. **Document survey results via a written report. (See attachment 1)**
   a. The actual survey was captured and saved. A more manageable and visually appealing summary report of six pages was also created and distributed widely through the state at all farm to school presentations (such as the local foods conference) and was included in all trainings and training manuals created through the duration of the grant.

4. **Review survey results and develop training plans for farmers and food service professionals.**
   a. The steering committee reviewed the survey and it advised the project coordinator to use as many "local" professionals to present trainings as possible for credibility within the state using both "boots on the ground" and "webinar" style sessions.

2011 December SURVEY RESULTS:

2011 School Food Service Survey

KEY POINTS

1. The majority of schools responding to the survey indicated they use less than five percent (5%) locally sourced fresh produce.
2. Demand for fresh local produce is growing; consistent and ample supply is lacking. There is a need for more producers.
3. There is also a need for education and working models to adopt within food service departments to learn how to work with local farmers.
4. There is a desire to network with farmers and a need for a directory to locate farmers willing to work with schools.
5. Questions remain about policies in regards to use of and procurement of fresh specialty crops from local farmers.

SURVEY SUMMARY:

A Farm to School survey was done with all schools in North Dakota that work with the Child Nutrition Division of the North Dakota Department of Public Instruction in December of 2011 with the assistance of Deb Egeland, assistant director.

The survey was completed by 97 schools. Partial surveys were included in these results; less than five "no response" surveys were discarded.

Briefly scanning the following document, it appears that many schools offer salad bars with a variety of fresh and canned fruits and vegetables and 61 percent have indicated a desire to offer more local products.

Currently vendors vary from commercial distribution companies such as Sysco all the way to the local grocery store. Twelve schools serve fresh produce from gardens and some receive donations of produce from local gardeners.

Many schools appear to have confidence in their staff's ability to use fresh vegetables and fruit. Many have equipment, but storage shelf life of fresh produce is a concern.

Reasons for not using local vary but include cost, availability and lack of information on how to purchase from farmers and where to find them. The biggest hurdles identified were inadequate supply of fresh and seasonality.

An over-arching theme appears to be the lack of producers and/or lack of time and money to work directly with farmers.

The top three resource requests were – a directory of farmers willing to supply schools; clarification of the rules for the purchase of produce from farmers; and successful models for farm to school programs.

Seventy-six percent of respondents said they use less than five percent local produce - our goal is to increase that by 15 percent.

OUTCOMES: The steering committee discussed the potential topics for training and suggested using as many local professionals as possible to make a connection with the school food service personnel. From the survey it was deduced that many schools felt it was not legal to purchase from farmers nor was that produce considered an "approved source." These main points were taken into consideration and an effort to break down the barriers of food safety concerns and procurement policies between farmers and cafeterias was a major focus of trainings.

PRODUCER SURVEY: (See attachment 2)

2011 Farm to School Producer Survey

KEY POINTS:

1. Farmers are interested in growing for local markets.
2. Farmers have land necessary to scale up production.
3. Specific information about product types, sizes, packaging and marketing rated high on needs.
4. Food safety training was an overlapping concern between producers and buyers.

SURVEY SUMMARY:

Only a small number of farmers completed the producer survey in conjunction with the school food service survey in December.

About half of the respondents were full-time farmers and sell products mostly by word-of-mouth.

The farmers who sold to schools in past years either couldn't meet the demand or the schools did not want to deal with fresh and local produce.

There is interest however in scaling production to meet the growing demands of farm to school and nearly all the respondents have the land available to do so.

The top answers for information sought for pursuing farm to school in the area were:

1. Information about specific products the schools will use.
2. Pricing strategies
3. Food safety requirements.

Preferred method of training was "in-person" including networking time.

Downloadable training documents and web-based trainings came in second.

A list of trainings was recorded by priority and will be offered as time and money become available.

1. **Create a directory of schools interested in sourcing local produce from survey and trainings and distribute to interested farmers; post on websites.**
    a. A directory was created with the information from the surveys. Additional schools and farmers have been added throughout the year.
    b. FARRMS' webpage at www.farrms.org has a listing with easy to click on email addresses to make contacts with farmers or schools.
    c. A printed copy of the directory with a plea for updates and additions was mailed to all farmers who took training or were in the directory as well as the North Dakota Department of Public Instruction mailing list for schools.

OUTCOMES: While there are interested farmers and schools there is still some trepidation in contacting with cold calls and more linkages need to be made with more networking sessions and model program sharing.

*The 2012 directory **listed 53 schools** that would be open to conversations with farmers about procuring locally grown specialty crops. A list of crops was provided to the schools as well as the farmers in both sets of surveys.*

2. **Plan, coordinate and publicize two trainings for produce farmers.**
    a. Two farm food safety trainings were held in April with a total of 21 participants.
    b. A certificate of completion from the Entrepreneurial Center for Horticulture at Dakota College in Bottineau was given to farms that completed the training and created a farm food safety plan presented to the instructor Keith Knudson, ECH Farm Business Manager.
    c. A hands-on farm food safety audit was held at one of the participating farms in August with seven participants including a representative of the State Department of Health Food and Lodging Division and an NDSU Extension Food and Consumer Science agent.
    d. A networking session was held in October with farmers and school food service cooks and directors with 12 participants.
    e. Four webinars are scheduled for Dec. 17-21 2012, for farmers, food service and general public to jumpstart the 2013 growing season for all parties.

OUTCOMES: We are bridging several state entities with our training programs. In an attempt to ease concerns over food safety our trainings were offered to all public health officials through the ND Department of Health listserv as well as schools through the ND Department of Public Instruction listserv. It was suggested that farmers that have completed the farm food safety training be designated as such in the new directory. Our partners are working together to identify a reasonable common explanation for "approved source" inasmuch as procuring food for schools and cafeterias.

The 2012 directory included 25 producers.

3. **Hold two one-day trainings for produce farmers on Good Agricultural Practices and Marketing to Institutions.**
    a. See item 5 for trainings. Manuals with templates for creating farm food safety plans were created and distributed. An actual farm food safety plan was shared with the class participants. Self-audits were discussed and a farm field tour was held to demonstrate how to do your own self-audit. Several resources for water and soil testing as well as information on documenting historical information about farms was shared with the students. ***Eight students have completed a***

***FARM FOOD SAFETY PLAN and received certificates of completion from the Entrepreneurial Center for Horticulture*. (SEE attachment 3)**

4. **Plan, coordinate and publicize two trainings for school food service professionals.**
    a. A networking training session was held in Medina in October 2012. The weather was a factor in attendance; however, the numbers were balanced at about 50 percent farmers and 50 percent food service. The conversation was introduced with the Farm to School film produced by Minnesota Extension Educator Farm to School Stephanie Hiem.
    b. Both parties asked for further networking sessions with time for questions. **(SEE attachment 4).**

5. **Hold two half-day trainings for school food service professionals on sourcing local produce.**
    a. ND State Farm to School lead Sue Balcom presented results of the survey to the local foods conference in February. Both producers and food service were represented in the audience.
    b. ND State Farm to School lead Sue Balcom presented "how to get started in farm to school" to food service conference in June.
    c. ND State Farm to School lead Sue Balcom presented at Friends and Family Day at the Northern Great Plains Research Station in Mandan.
    d. Two food service webinars were held prior to Farm to School week –
        i. August – Buying produce from farmers with 7 participants and guest speaker Melissa Anderson, RD,LD,SNS Foodservice Director Holdingford and Rocori Schools in Minnesota.
        ii. September – Nourishing Communities with Doug Davis, food service director for Burlington, VT, school district.
        iii. Webinar week for farms, schools and anyone interested in purchasing or growing more specialty crops from Dec. 17-21 has 56 registrations as of Dec. 13.

OUTCOMES: Deb Egeland, School Nutrition Programs Manager, with the North Dakota Department of Education was able to contribute significantly to outreach by including an hour-long "training/informational" session on how to begin Farm to School at the annual conference for food service in Bismarck, ND. Sue B. Balcom presented to nearly 200 professionals. Also, two webinars with guest food service personnel from Minnesota and Vermont were held in August before North Dakota Farm to School Week – September 16-22. An additional "face-to-face" was held in October at FARRMS in Medina. Surveys and evaluations were collected from each of these sessions. With a significant savings in the cost of classroom rental through connections and partnering with organizations such as Farm Credit Services and NDSU Extension four more webinars are being offering the week of December 17-21 for both producers and food service personal in addition to any other partners or residents wishing to become more involved in increasing specialty crop production for food service.

Webinar Week series evaluations: (SEE attachment 5)

The Survey Monkey subscription provides unlimited survey capabilities and was used for nearly ever training and function held in conjunction with Farm to School and specialty crop production. Surveys were used to specifically hold topic trainings and webinars. Renewal of the

subscription the Survey Monkey tool will be used for every future event for farm to school in North Dakota. The results of workshop evaluations provided topics and subjects for future discussion about how to reduce the barriers between schools and farms.

FOOD SERVICE TRAININGS WERE INCREASED FROM TWO TO SEVEN with the use of webinars.

6. **Produce on-line webinars of farmer and food service professional trainings to be posted on the FARRMS website.**
    a. The Web consultant fee of $1,200 was used to purchase a subscription to GoToTraining. This provides unlimited opportunities for sessions and meetings on a web-based platform. The webinars can be recorded and uploaded for viewing at a later date as well as put on FARRMS YouTube channel for everyone to view at their convenience. This provides an opportunity to host webinars with speakers from all over the country at a time that is convenient to food service directors and producers. This work was completed by FARRMS with the assistance of KAT Communications in Bismarck; our Web provider.
    b. The webinar recordings are going to be linked to the new Farm to School web page at www.ndfarmtoschool.org.

OUTCOMES: GoToTraining is a wonderful platform for reaching the entire state of North Dakota. While boots on the ground trainings and networking will still be scheduled, webinars can be scheduled at opportune times quickly and conveniently. The North Dakota Department of Public Instruction, Facebook, webpages, North Dakota State Department of Health, the North Dakota Department of Agriculture, the North Dakota Farmers Market and Growers Association, the Entrepreneurial Center for Horticulture, Northern Plains Sustainable Agriculture Society, NDSU Extension and the Farm to School Steering Committee are partnering to advertise and encourage participation in these events.

7. **Market the on-line webinars.**
    a. See 10 for information on webinars. Using Web pages, emails, Facebook, YouTube and other social media we can advertise webinars quickly and efficiently. Partner listservs are also used as well as media releases to all newspapers, television stations and radios in the state.
    b. GoToTraining has the ability to upload all class documents for downloading at any time as well as email reminders for upcoming Webinars and links to the online recordings.

8. **Conduct a second survey of school food service professionals to document the volume of local produce sourced and obstacles experienced**.
    a. Survey was designed and distributed in November and December of 2012.

2012 Food Service follow-up survey: (SEE attachment 6)

Farm to School Food Service follow up survey

KEY POINTS

- Based on the number of respondents - Salad bar offerings remain at about 50 percent of the schools offering salad bars five days a week.
- New USDA meal pattern implementation occupied school food service personnel detracting from any efforts to source more specialty crops locally.
- There is still a need for education and working models to adopt within food service

departments to learn how to work with local farmers.

- There is a desire to network with farmers however barriers of seasonality and finding farmers still remain.
- More schools participated in Farm to School activities, but would like more information and opportunities to educate students about farming.
- There is interest in webinar based education and training videos.

SURVEY SUMMARY:

A Farm to School survey was done with all schools in North Dakota that work with the Child Nutrition Division of the North Dakota Department of Public Instruction in December of 2011 with the assistance of Deb Egeland, assistant director.

A second survey was done in December of 2012 and a snippet of the survey that compares the 2011 data with 2012 is included below. The full survey is available upon request.

The number of respondents was down but the offerings of fresh and frozen fruit and vegetables remained high. 2011 data shows a total of 93 responses compared with only 67 responses in 2012, down 28%. Even though the responses decreased in 2012, survey results show the average of five days per week for fresh fruits and vegetables increased from 37% to 54%, an increase of 17%, up from our goal of 15%.

Through the follow up survey, we are able to assert that the interest in specialty crops is high by figuring out the percentage and comparing with the prior year, even if there was less of a response.

2. On average how many days per week during the regular 2011-2012 school year did you offer a la carte fresh fruits and/or vegetables? Frozen or fresh, not canned vegetables?

2012

	0	1	2	3	4	5	NA	Response Count
Elementary	11.9% (8)	6.0% (4)	3.0% (2)	10.4% (7)	7.5% (5)	**49.3% (33)**	11.9% (8)	67
Middle/Junior High	8.5% (5)	5.1% (3	1.7% (1)	6.8% (4)	5.1% (3	**57.6% (34)**	15.3% (9)	59
High School	6.9% (4)	5.2% (3)	1.7% (1	5.2% (3)	5.2% (3)	**56.9% (33)**	19.0% (11)	58

2011

	0	1	2	3	4	5	NA	Response Count
Elementary	19.4% (18)	4.3% (4)	12.9% (12)	15.1% (14)	8.6% (8)	**35.5% (33)**	4.3% (4)	93
Middle/Junior High	16.9% (13)	2.6% (2)	14.3% (11)	11.7% (9)	10.4% (8)	**36.4% (28)**	7.8% (6)	77
High School	15.4% (12)	2.6% (2)	11.5% (9)	12.8% (10)	10.3% (8)	**39.7% (31)**	7.7% (6)	78

Number of offerings of fresh and frozen vegetables and fruits increased to more than 50 percent of the respondents in 2012 as compared to 35 percent of respondents in 2011 showing a slight increase.

The items are offered ala carte but not charged separately from the meal, giving students the option of building their own salads.

2011 data shows 29 schools responded to how much they purchased from farmers. The

2012 data shows that 69 schools responded to the same question, giving a 138% increase in response. From the information received below, we see that the number of sales to schools in the $0-100 range increased with the amount of responses, but still had about the same percentage at about 70 percent. The 2012 data shows an increase of over 4% in the $101-500 and the $501-1,000 increased from 7% to 10%. The survey asked for produce and fruits purchased and were also explained at the end of the survey, so we believe the amount purchased was solely specialty crop sales. The table below shows the survey responses from each year.

Respondents Specialty Crops Sales					
	$0-100	$101-500	$501-1,000	More than $1,000	Total
2011	20	5	2	2	29
2012	47	15	7	0	69

The 2011 baseline data of fruit and vegetable producers supplying institutions was incredibly small. Only one of the 14 respondents supplied institutions with fruits and vegetables, a low 7%. The follow-up survey, taken in the 2012-2013 school year noticed an increase from 7% to 20% (6 of 30) producers supplying institutions. Our outcome was anticipated at increasing 5%, and we beat it with a 13% increase from the prior year.

Many schools do not purchase from farmers but accept donations from local gardeners as well as use produce from school gardens.

9. **Review survey findings and project results with steering committee.**
    a. Survey results will be available at the annual Northern Plains Sustainable Agriculture Society Winter Conference and work plan for the upcoming SCBG will be added to the North Dakota Farm to School programming for 2013-14.

The current farm to school steering committee reviewed and compared the surveys in January of 2013. Suggestions and conclusions drawn from the surveys include these action items:

- Hold more education opportunities to increase the knowledge of how the school meal pattern and foodservice operates within the school districts.
- Address farmer and school food service networking needs on an ongoing basis –
    - Suggestions were made to present a workshop at the Local Food Conference in April; and present a workshop at the School Nutrition Providers Conference in June. Also if it is possible to pay the $450 booth fee, farmers could collectively have a booth at the SNP conference in Fargo.
- Begin to form regional food hubs/cooperatives/alliances of producers to aggregate product to meet the needs of larger schools and school districts. One of the Webinars addressed the topic of how a coop could benefit farmers and schools.
- Create a complimentary database to the school/farmer directory of particular needs (i.e. carrots, tomatoes, cucumbers) and the amounts used for lunches in participating schools to promote matchmaking.
- Increase education and use of season extension such as hoop houses and high tunnels.
- Focus on marketing “safe” food purchased from farmers, rather than limiting specialty crops locally to the donated garden produce, with further certification and training opportunities.
- The steering committee suggested farmer/school networking events to be held regionally in August in schools including tours of kitchens and information about procurement and preparation methods exclusive to Federal meal pattern requirements.

Additional work included a second producer survey after cumulative trainings. **(See attachment 7).**

Farm to School Producer Survey 2012-13
KEY POINTS:

1. Respondent numbers were down; however interest in working with schools remains high.
2. Pricing and networking with food service directors appears to be an urgent producer need.
3. There were many high tunnels erected in the state this past year, but there appears to be a need for high tunnel education to coincide with these new producers.
4. Carrots, peppers and cucumbers are the most popular specialty crops grown

PRODUCER EVALUATION SUMMARY:

This second producer survey was not a requirement of the Specialty Crop Block Grant, but was done additionally to cultivate connections to producers and continue to collect information to enhance education programs.

Although the number of producers answering these questions was smaller than a year ago, interest in Farm to School continues to grow. Many farmers are adding high tunnels to their production methods but indicate additional information and training is needed to best utilize season extension.

There is a demand for a liaison between farmers and school food service directors. The lack of knowledge about how schools procure fruits and vegetables and/or other food products is a barrier to farmers.

Many questions remain as to how to begin the conversation with schools; how to price products for competitive sales; and how to package, size and deliver to schools competitively.

Farmers are aware of Farm Food Safety needs and completing a farm food safety plan will be a marketing asset for approaching schools.

10. **Complete a full written report of all project findings and share with steering committee and stakeholders.**
    a. All reports are available from FARRMS for the asking. This document will be sent to the steering committee and partners in February via email.

Beneficiaries

Clearly the awareness of farm to school in the state has been significantly increased. There were six or so major celebrations of North Dakota Farm to School Week in September, Farm to School Month in October and Food Day – an increase from 0 reported in 2011.

In 2012 there were 53 schools and 25 producers in the Farm to School Directory and in 2013 there were 70 schools listed and 26 farms. **(See attachment 8).** Many farmers expressed fear at committing to work with schools without more information about what they want, how they want it prepared and delivered, and would they have enough product to provide even a small school.

School interest has increased by 75 percent. However, the schools again indicated they could not find farmers and a growing barrier to procurement is the donation of food from gardeners in small communities providing ample produce without actually supporting a farmer through purchases.

The following farmers have completed a Farm Food Safety Plan and received a certificate of completion/approval from the Entrepreneurial Center for Horticulture:
Alyce Lunde
Apryl Lunde
Eden McLeod
Janel Anderson
Jeremy Lewis
Marcia Dahl Hetland
Lori Martin
Tracie Thompson

Lessons Learned

Barriers to North Dakota Farm to School are still high. There is a hesitation to trust farm food that is wholly based on lack of education and not founded in reality. There is a lack of producers who are willing to scale up production without some agreement with the schools. Confusion over state health regulations as to what can and cannot be purchase also exists from both the farmer and the food service perspective.
It is extremely frustrating to bring growers and buyers together to find they resort to the path of least resistance and go about their business.
While interest remains high it is difficult to start new programs or track activity without a full time farm to school coordinator.
The good news is as a result of trainings and surveys and the directory there is increased conversation between farmers and food service. New producers are showing up all the time and are willing to talk to schools.
Surveys showed an increase in the use of local foods to supply salad bars in the schools that completed the survey and farm to school week has received more local press indicating more awareness and education opportunities are being utilized.

Contact

Sue B. Balcom
sbalcom@farrms.org
701-527-5169

Additional Information

Full reports are available upon request. Please contact Sue Balcom at the above email address.

1. 2011-12 Farm to School Food Service survey.
2. 2011-12 Producer survey.
3. Farm Food Safety Training Evaluation
4. Oct. 18, 2012 networking evaluation
5. December Webinar Series evaluation
6. 2012 Food Service survey follow up
7. 2012 Producer survey
8. 2013 Farm to School directory
9. 2012 Farm to School handbook
10. 2012 General Farm to School Info Brochure

School Food Service Directors Survey

December 2011

KEY POINTS

1. The majority of schools responding to the survey indicated they use less than five percent (5%) locally sourced fresh produce.
2. Demand for fresh local produce is growing; consistent and ample supply is lacking. There is a need for more producers.
3. There is also a need for education and working models to adopt within food service departments to learn how to work with local farmers.
4. There is a desire to network with farmers and a need for a directory to locate farmers willing to work with schools.
5. Questions remain about policies in regards to use of and procurement of fresh specialty crops from local farmers.

SURVEY SUMMARY:

A Farm to School survey was done with all schools in North Dakota that work with the Child Nutrition Division of the North Dakota Department of Public Instruction in December of 2011 with the assistance of Deb Egeland, assistant director.

The survey was completed by 97 schools. Partial surveys were included in these results; less than five "no response" surveys were discarded.

Briefly scanning the following document, it appears that many schools offer salad bars with a variety of fresh and canned fruits and vegetables and 61 percent have indicated a desire to offer more local products.

Currently vendors vary from commercial distribution companies such as Sysco all the way to the local grocery store. Twelve schools serve fresh produce from gardens and some receive donations of produce from local gardeners.

Many schools appear to have confidence in their staff's ability to use fresh vegetables and fruit. Many have equipment, but storage shelf life of fresh produce is a concern.

Reasons for not using local vary but include cost, availability and lack of information on how to purchase from farmers and where to find them. The biggest hurdles identified were inadequate supply of fresh and seasonality.

An over-arching theme appears to be the lack of producers and/or lack of time and money to work directly with farmers.

The top three resource requests were – a directory of farmers willing to supply schools; clarification of the rules for the purchase of produce from farmers; and successful models for farm to school programs.

Seventy-six percent of respondents said they use less than five percent local produce -- our goal is to increase that by 15 percent.

Sue B. Balcom - ND State Lead Farm to School
sbalcom@farrms.org
301 5th Av SE, Medina, ND 58467
701-527-5169

NORTH DAKOTA farm to school

Producer/Farmer Survey

Jan.-Feb. 2012

KEY POINTS:

1. Farmers are interested in growing for local markets.
2. Farmers have land necessary to scale up production.
3. Specific information about product types, sizes, packaging and marketing rated high on needs.
4. Food safety training was an overlapping concern between producers and buyers.

SURVEY SUMMARY:

Only a small number of farmers completed the producer survey in conjunction with the school food service survey in December.

About half of the respondents were full-time farmers and sell products mostly by word-of-mouth.

The farmers who sold to schools in past years either couldn't meet the demand or the schools did not want to deal with fresh and local produce.

There is interest however in scaling production to meet the growing demands of farm to school and nearly all the respondents have the land available to do so.

The top answers for information sought for pursuing farm to school in the area were:

1. Information about specific products the schools will use.
2. Pricing strategies
3. Food safety requirements.

Preferred method of training was "in-person" including networking time.

Downloadable training documents and web-based trainings came in second.

A list of trainings was recorded by priority and will be offered as time and money become available.

FARRMS Learn Grow Live

Sue B. Balcom - ND State Lead Farm to School
sbalcom@farrms.org
301 5th Av SE, Medina, ND 58467
701-527-5169

FARM FOOD SAFETY EVALUATIONS
April 20 and 27, 2012 sessions

CONCLUSIONS: These workshops were very helpful in increasing the awareness of the need for Farm Food Safety or GAPS in specialty crop production. There is also an increased knowledge of the differences between farmers and food service needs and the demand for locally grown fruits, vegetables and herbs.

Farmers need assistance in approaching and marketing to schools as well as technical assistance with planning for specialty crop production.

Attendees took away the need for farm food safety record keeping and practices as well as the tools to implement Farm Food Safety on their respective farms.

These workshops also solidified the partnership between ND Farm to School and the Entrepreneurial Center for Horticulture at Dakota College in Bottineau.

FARRMS FARM FOOD SAFETY WORKSHOP EVALUATIONS - APRIL 20 AND 27

	DISAGREE	TEND TO DISAGREE	TEND TO AGREE	AGREE
Pre workshop communications were adequate for preparation		1	3	10
Design of workshop facilitated networking and exchange of ideas		1	2	11
Workshop engaged me in active learning		1	2	11
Keith Knudson did a great job of presenting				14
I will recommend FARRMS training to my friends			3	11

COMMENTS:

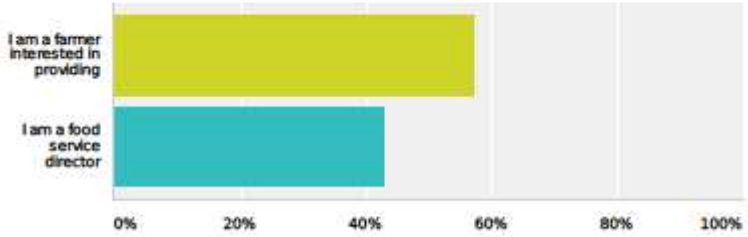
What is one thing that amazed you?

The amount of demand for local foods in schools
Similarity between farming, harvesting and routine food service operations
Farm to School needs for farmers wanting to participate

Farm Food Safety Training Session Evaluations - 1

Q1 Greetings and thank you for taking the time to provide feedback about our networking session held on Oct. 18 in Medina. Please complete the questions to the best of your ability; we need your input to continually provide better services. It should only take a few minutes of your time.

Answered: 7 Skipped: 0



Answer Choices	Responses	
I am a farmer interested in providing specialty crops (fruits and vegetables) to schools.	**57.14%**	4
I am a food service director interested in using more local foods and fruits and vegetables.	**42.86%**	3
I am not a farmer or food service director but am very interested in local foods. I am a (0)		
Total		7

How to hold an Iron Chef Competition for fundraising 12.17.12

Attendees Registered	Attended	Email
David Rice	YES	riceda@fargo.k12.nd.us
Dana Rieth	NO	drieth@icsc.org
Heidi Demars	YES	heididemars@hotmail.com
Roxanne Dallmann	YES	grdallmann@bektel.com
Lynelle McKenzie	YES	lynelle.mckenzie@sendit.nodak.edu
Julie Tunseth	YES	julie.tunseth@gfschools.org
Grant Whitehurst	NO	boygrantjax@gmail.com
JoAnne Ziegler	YES	jowolf@min.midco.net
Marietta Good	YES	Marietta.good@ndsu.edu
Sue Milender	YES	sue.milender@sendit.nodak.edu
Lynn Wolff	YES	lynn@drc.info.com
Deb Belquist	NO	dprca@hotmail.com
Anne Biewer	NO	Anne.E.Biewer@sendit.nodak.edu
Deb Egeland	YES	degeland@nd.gov
Peder Gulleson	NO	pedergulleson@gmail.com

POLL QUESTION – Do you know what an Iron Chef Competion is…
YES = 3
No = 3

EVALUATION:

Is this the first online webinar you have attended? NO = 3 YES = 6

How would you rate the information you received today? Excellent = 6 Neutral = 2

Please rate the presenter on a scale of 1 to 5 with 5 being excellent and 1 being "boring."

1 = 0 2 = 0 3 = 3 4 = 2 5 = 4

Please list topics you are interested in learning about through online trainings.

- CSA planning; generating sales networks; using high tunnels in the Dakotas to extend seasons; alternative crops.
- Farm networks, School/farm interaction, farm cooperatives, and public outreach/farms.
- Farms to schools connections, rural economy, cooperative farming, organic farming, and small-scale specialty farms.

How likely are you to implement any of the information you learned today for Farm to School and/or Cafeteria in your community?

I'm thinking about it = 3 Absolutely = 5 Not likely = 1

School Food Service Directors Survey

December 2012

KEY POINTS

1. Based on the number of respondents - Salad bar offerings remain at about 50 percent of the schools offering salad bars five days a week.
2. New USDA meal pattern implementation occupied school food service personnel detracting from any efforts to source more specialty crops locally.
3. There is still a need for education and working models to adopt within food service departments to learn how to work with local farmers.
4. There is a desire to network with farmers however barriers of seasonality and finding farmers still remain.
5. More schools participated in Farm to School activities, but would like more information and opportunities to educate students about farming.
6. There is interest in webinar based education and training videos.

SURVEY SUMMARY:

A Farm to School survey was done with all schools in North Dakota that work with the Child Nutrition Division of the North Dakota Department of Public Instruction in December of 2011 with the assistance of Deb Egeland, assistant director.

A second survey was done in December of 2012.

The number of respondents was down but the offerings of fresh and frozen fruit and vegetables remained high.

An increase of 15 percent or more was seen in the fresh and frozen offerings in salad bars. The items are offered ala carte but not charged separately from the meal, giving students the option of building their own salads.

The number of sales to schools in the $0-100 range remained the same at about 70 percent of respondents with 10 percent in the more $500 to $1,000 range. This number appears to have increased.

Many schools do not purchase from farmers but accept donations from local gardeners as well as use produce from school gardens.

Sue B. Balcom - ND State Lead Farm to School
sbalcom@farrms.org
301 5th Av SE, Medina, ND 58467
701-527-5169

NORTH DAKOTA farm to school

Producer Survey

December 2012

KEY POINTS:

1. Respondent numbers were down; however interest in working with schools remains high.
2. Pricing and networking with food service directors appears to be an urgent producer need.
3. There were many high tunnels erected in the state this past year, but there appears to be a need for high tunnel education to coincide with these new producers.
4. Carrots, peppers and cucumbers are the most popular specialty crops grown

EVALUATION SUMMARY:

This second producer survey was not a requirement of the Specialty Crop Block Grant, but was done additionally to cultivate connections to producers and continue to collect information to enhance education programs.

Although the number of producers answering these questions was smaller than a year ago, interest in Farm to School continues to grow. Many farmers are adding high tunnels to their production methods but indicate additional information and training is needed to best utilize season extension.

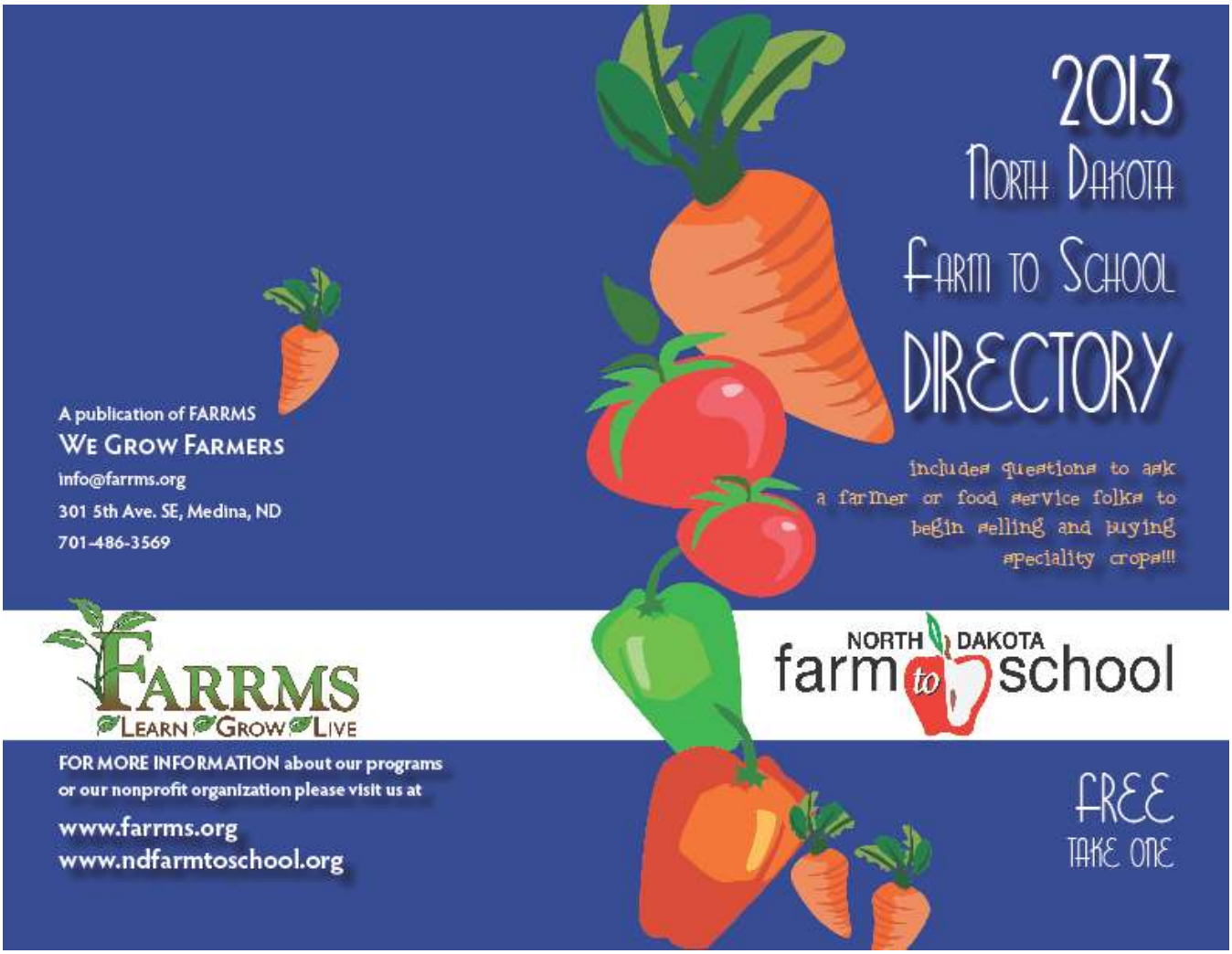
There is a demand for a liaison between farmers and school food service directors. The lack of knowledge about how schools procure fruits and vegetables and/or other food products is a barrier to farmers.

Many questions remain as to how to begin the conversation with schools; how to price products for competitive sales; and how to package, size and deliver to schools competitively.

Farmers are aware of Farm Food Safety needs and completing a farm food safety plan will be a marketing asset for approaching schools.

FARRMS Learn Grow Live

Sue B. Balcom - ND State Lead Farm to School
sbalcom@farrms.org
301 5th Av SE, Medina, ND 58467
701-527-5169


2013
North Dakota
Farm to School
DIRECTORY
includes questions to ask a farmer or food service folks to begin selling and buying speciality crops!!!
A publication of FARRMS
We Grow Farmers
info@farrms.org
301 5th Ave. SE, Medina, ND
701-486-3569
FARRMS
Learn Grow Live
NORTH DAKOTA
farm to school
FOR MORE INFORMATION about our programs or our nonprofit organization please visit us at
www.farrms.org
www.ndfarmtoschool.org
FREE
TAKE ONE

Please fill in the reverse side of this page and mail to:

SUE B. BALCOM
North Dakota Farm to School Coordinator
FARRMS, 301 5th Avenue SE, Medina, ND 58467

20

NORTH DAKOTA farm to school

NORTH DAKOTA
FARM TO SCHOOL COORDINATOR
Sue B. Balcom
2145 34th Street, Mandan, ND
Phone: 701-527-5169
Email: sbalcom@farrms.org

(LIVE IN FEBRUARY)
www.ndfarmtoschool.org

www.farmtoschool.org
www.farmtopreschool.org

FARRMS LEARN GROW LIVE

301 5th Avenue SE,
Medina, ND 58467
701-486-3569 or
info@farrms.org

We Grow Farmers...

1


Starting a Farm to School or Cafeteria Program in Your Community
FOR MORE INFORMATION about our programs or nonprofit organization please visit us at
www.farrms.org
FARRMS
Learn Grow Live
North Dakota farm to school
includes information on school gardens
A publication of FARRMS - the foundation for sustainability, Medina, ND and Northern Plains Sustainable Agriculture Society, LaMoure, ND
Revised April 2013

Table of Contents

NORTH DAKOTA farm to school

What is Farm to School?

Farm to School can be any program that connects schools (K-12) and local farms with the objectives of serving healthy meals in school cafeterias, improving student nutrition, providing agriculture, health and nutrition education opportunities, and supporting local and regional farmers.

Farm to School programs exist in all 50 states, but since Farm to School is a grassroots movement, programs are as diverse as the communities that build them.

FARM TO SCHOOL PROGRAMS ARE KNOWN TO:

- Promote healthy eating habits and reduce risk of obesity and other health related disorders in children.
- Provide children access to local, healthy and nourishing foods.
- Facilitate education about nutrition, food and agriculture in and out of the classroom.
- Increase school meal participation rates.
- Open up new markets and increase revenues and customer base for farmers.
- Develop community support and awareness about local food systems.

SOURCE: National Farm to School. www.farmtoschool.org

(Please leave this with a FARRMS staff or mail to: FARRMS, 301 5th Ave SE, Medina, ND 58467)

Name _____

Address _____ City, State, Zip _____

Best way to contact me is by: Phone: _____ Cell Phone: _____ Email: _____

YES, I would like more information about

NORTH DAKOTA farm to school

I am a
- Producer/Farmer
- Cook
- Food Service Director
- Superintendent
- Teacher
- Parent
- Distributor

I am interested in trainings on:
- Safety Issues
- Liability Issues
- Networking
- Insurance Requirements
- School/Producer Networking
- Field Trips
- Curriculum
- (other) _____

Please include me in your directory of ND Farm to School producers

NORTH DAKOTA farm to school

PROJECT 4: INCREASING FARMERS MARKET VIABILITY THROUGH TRAINING AND VENDOR RECRUITMENT

Final Report

Project Summary

In 2008 and again in 2010, the farmers markets of North Dakota were surveyed to determine consumer satisfaction with and suggestions for improvement of the markets in their community. In both surveys, the number one suggestion for improvement was 'more vendors'. The majority of North Dakota farmers markets are managed by volunteer staff with little or no training in recruitment, organizational management, or marketing.

In 2011, the NDFMGA used Federal Farmers Market Promotion Program grant dollars to increase the popularity of farmers markets with consumers across the state. This increase in demand for farmers market produce, along with increased awareness of the location and availability of markets further accentuated the need for increasing the number of vendors at markets.

The 2011 Specialty Crop Block Grant project assisted with increasing the number of vendors, the training of market managers and also provided an opportunity for students in North Dakota schools to learn about the production and marketing of vegetables through a school garden grant program to encourage young people to enter into the production of specialty crops as an entrepreneurial venture.

Through this project, the NDFMGA:

- Increased the skills of market managers as they built the stability and viability of their markets by writing, customizing, delivering, and after care of online training for market managers.
- Provided funding incentive for market managers to complete the training.
- Provide funding for submission of a market plan and final report to include strategies for recruitment of fruit and vegetable vendors or increases of specialty crop sales at their markets.
- Ensured that trained market managers were aware of the policies and regulations of the state of North Dakota that govern the sale of fresh fruits and vegetables in a farmers market setting.
- Provided a recruitment tool for markets and incentive for new fruit and vegetable farmers and producers to enter the farmers market arena by supplying funding for equipment necessary to display and sell at a farmers market such canopies, tables, carts, bins and other necessary items.
- Provided a mechanism for students to explore production and marketing of vegetables through a school garden grant program.
    - The goal was to give students at ten North Dakota schools the opportunity to learn about the production and marketing of vegetables. This is a continuation of a popular program that has been very cost effective. Previous years have shown that once the school gardens get this boost to start the program, they continue in future years without grant money.

- The funding for this program allowed the expansion to other schools in North Dakota so they may begin a school garden or establish a greenhouse operation.

This project builds on work previously completed by the NDFMGA by strategically acting upon survey results gathered in 2008 and 2010. Over 5,000 market shoppers were surveyed in 2008 and over 3,000 in 2010. Both of the stated surveys revealed consumers stated a desire for increased number of vendors (90% response rate in 2008 and 30% in 2010) and an increase in the variety of produce at the market (50% in 2010).
Specialty Crop grant funds were used in 2010 to gather data from markets in regards to variety and availability of produce at the North Dakota farmers markets. The results revealed a surprising disparity amongst the markets. Several markets had as few as 13 different qualifying specialty crops and others had as high as 60. By limiting the availability of funding through this program to only producers of qualifying specialty crops, the NDFMGA hoped to increase the variety of produce at farmers markets and the number of vendors selling said crops. Increasing both the variety and amount of produce at farmers markets will build the long term impact of the project.

Although the School Garden Grants portion of this project has been funded through North Dakota Department of Agriculture Specialty Crop grant funds in the past; this project as a whole has not been submitted to or funded by any other federal or state grant program.

The NDFMGA took great care to ensure that all funds were used to solely enhance the competitiveness of eligible specialty crops. The NDFMGA used the following to ensure the funds solely enhanced the competitiveness of specialty crops:

- Green and Growing School Garden grants were given to only schools who outlined in their application proposal a garden plan that was solely producing specialty crops.
- New Vendor grants were awarded to new vendors whose sole product for sale at farmers markets was a specialty crop.
- Market manager training stipends were given to applicants who markets had a majority of vendors selling specialty crops and additional funds from the North Dakota Department of Agriculture were added to this program to cover the percent of non-specialty crop vendors. Market managers had to focus their training on specialty crops by designing marketing plans and recruitment efforts that would benefit specialty crop vendors at their markets.

Project Approach

The activities and tasks that took place to accomplish this grant are as follows:

Project Activity	Who	Timeline
Training for Market Managers		
Locate and begin customization of market manager training curriculum	ECH staff and Committee of the Board of Directors of the NDFMGA – **Complete – four curriculums from other states were evaluated, three reference materials outlining North Dakota specific regulations were**	November 2011

	assessed and portions of all were included in the final curriculum.	
Conclude customization of curriculum and moving modules to online format	ECH staff and Committee of the Board of Directors of the NDFMGA – **Complete – the final online curriculum includes topics such as: market location, operating hours, market organization, insurance, budgeting and finance, membership, identifying resources, creating rules, collecting data for evaluation, envisioning your role in your community, vendor vitality, value and quality, managers as leaders and promotions and events. The final curriculum has 31 reading assignments, 12 videos to review, 8 PowerPoint presentations to review, and 32 worksheets, quizzes and planning forms for participants to complete along with a final project summary that must be submitted along with coursework for successful completion of the program.**	January 2012
Announce program to local farmers market managers	NDFMGA staff - **Complete – this was done via newsletter, direct mail, social media and post cards.**	February 2012
Close of application time for market managers	NDFMGA staff and local farmers market managers - **Complete**	April 2012
Market Managers registered and begin work in online course	Local farmers market managers and ECH/NDFMGA staff - **Complete**	May to July 2012
Coursework completed by all managers	Local farmers market managers and ECH/NDFMGA staff – **Twenty five managers have completed and successfully turned in final plans.**	August 2012 – extended to November 2013
Final reports due by all participating market managers	Local farmers market managers and ECH/NDFMGA staff – **Complete, twenty five managers submitted plans including strategies for increasing sales or vendors of specialty crops for their markets.**	November 2012 – extended to November 2013
Meeting to assess results, measure successes and plan for future	NDFMGA Board of Directors and ECH/NDFMGA staff – **Completed at the annual meeting and strategic**	February 2013

	planning February 2013.	
Mini Grants to Farmers/Producers		
Application for grants sent to local farmers markets and producer/farmers	NDFMGA – **Completed via direct mail, social media, post card and newsletter article.**	February 2012
Deadline for submitting applications	Producer/farmers - **Complete**	May 2012 – extended to September 2013
Grant moneys approved and distributed	NDFMGA – **Complete, in total 30 new vendors applied and were granted funds.**	June 2012 – extended to October 2013
Copies of receipts due to NDFMGA	NDFMGA and local Producer/farmers – **Complete – 30 new vendors submitted receipts and photos or lists of the specialty crops they grew and sold.**	*December 2012 Deadline extended to November 1, 2013
School Garden Grants		
Invitation to request school garden grants	NDFMGA – **Complete – an email with the grant application and guidelines was emailed to all school administrators (477).**	January 2012
Deadline to receive applications	Local schools - **Complete**	March 2012
Grant awards made	NDFMGA- **Complete – all applications were evaluated for completeness and the presence of specialty crop items in their plans for crops.**	April 2012
Projects completed	Local schools **- Complete**	November 2012
Final reports due	Local schools **– Complete, in all 10 schools were awarded $500 each to begin a school garden program. All 10 submitted final reports detailing the specialty crops they raised, how they would continue the work and who their community partners were. One additional school was originally awarded funds but did not finish the program and sent back the $500 and thus it was redistributed to another school.**	December 2012
Measurement and Outcome Planning		
Meeting to assess results, measure successes and plan for future	NDFMGA Board of Directors and ECH/NDFMGA staff – **Complete, after**	February 2013

	reviewing the success of the program and the remaining funds, an extension was requested and received from the North Dakota Department of Agriculture to carry over this project until December 1, 2013.	
Final Reporting to NDDA	NDFMGA Board of Directors and ECH/NDFMGA staff	February 2013 – deadline extended to December 1, 2013

Throughout the project, the ECH at Dakota College at Bottineau has provided personnel and support for all of the goals and tasks involved in this project. Without the partnership of the ECH, many of these tasks would not have been possible to complete. The North Dakota Farmers Market and Growers Association recognizes the value of this partnership and would like to recognize the significant assistance it receives from Dakota College and specifically the ECH personnel who work so hard to make the NDFMGA programs a success.

Goals and Outcomes Achieved

Goal 1: Increase the stability and ability of markets to recruit and support vendors.
The staff of the Entrepreneurial Center for Horticulture (ECH) at Dakota College at Bottineau researched market manager training curriculums already prepared across the nation. Using these as bench marks, the ECH staff along with the NDFMGA Board of Directors Manager Training Committee identified curriculum items to include in the training along with state specific issues and regulations that would be covered in the training. ECH staff designed and wrote the final curriculum and had it approved by the NDFMGA Manager Training Committee. The ECH staff worked on behalf of the NDFMGA to market the opportunity for training to all farmers market managers within the state via social media, post cards and newsletters. Market manager enrollment in online training was tracked and class participation and achievement measured through Dakota College at Bottineau Entrepreneurial Center for Horticulture. Successful completion of the training curriculum was marked by completion of a series of exercises culminating in a strategic market plan. Successful completion of training by participants was reported to the NDFMGA. Market managers who completed the training were additionally assessed through submission of a final report at the end of the market season.

Impact of the training and its effect on specialty crops was measured using the statements the market managers made throughout their final report. Such statements included:

- "At market times this year we are going to have two specialty crops each time that are for everyone to sample. Along with having the produce out to sample, we will offer some recipes using the produce",
- "We will create a theme for the month and vendors would cook a certain vegetable, for ex: potatoes, onions, or asparagus and sell at market",

- "We began a website to show pictures of the market and vegetables available, Friday special events that feature a particular vegetable now available",
- "We offer a lunch with veggies grown by vendors – we put the money made back into the market… we offer whole samples of produce that lends itself to that (cherry tomatoes, carrots, peas, etc.)",
- "We now have a community partner group to help govern the market – we host food demos with specialty crop products/produce",
- "We are taking the opportunity to introduce community to unusual produce or a seasonal niche, such as Armenian and lemon cucumbers, tomatoes with skin coloring red, black, yellow, purple kohlrabi, red cabbage, kale, etc.",
- "We plan to implement a veggie or fruit of the week that would showcase that specialty crop. Have a "fest" to celebrate a specialty crop. For example pumpkins, vendors could not only sell their varieties but also bake many goods showing how diverse their crop is, and add a recipe with the taste and the produce".

The manager's final reports indicate they are more open to finding lines of communication to enhance the farmers market selling and have more vendor camaraderie. The managers have learned policies that are very beneficial to the successful implementation of the market and that promotion for the market and vendors is something that can be easily achieved if time is being put in. Some of the managers are very interested in using their specialty crops to entice customers to buy more product by cooking with it or giving samples for the customers as allowed by local health regulators. The final report submitted by the market managers included the strategies that were implemented, areas for improvement, obstacles to completion and how the knowledge of training impacted them as managers and the market as a whole. Each final report was read by the NDFMGA Executive Director to ensure that marketing plans, vendor recruitment efforts or changes to operations included statements by the manager in regards specifically to its impact on specialty crop vendors.

All training for farmers' market managers was provided to only managers of markets whose majority of vendors and products sold are eligible specialty crops. Additional funds from the North Dakota Department of Agriculture were used to supplement the market manager training stipends to cover the market managers' time proportional to the non-specialty crops at their markets. The supplemental funds totaled $4,000 which is 29% of the cost of this program to cover costs associated with non-specialty crops sold at the markets. It is estimated that 75% of the farmers market activity is related to specialty crops. At the end of the first round of training, the ECH staff and the NDFMGA Board of Directors met to evaluate the effectiveness of the training. Each Director reviewed the final market plans from several markets and shared their insights with the group. It was determined, based on the final plans, that the training was beneficial in getting managers aware of how best to market specialty crops within their communities, how to reach out to new specialty crop vendors and how to maintain the stability and viability of their communities and markets to ensure a venue for the sale of specialty crops was available. The goal for this portion of the project was to train at least 20 market managers with a vision of 25 tops. Twenty five participants received and completed training, eight other participants began training but did not successfully complete.

Goal 2: Increase the number of vendors of specialty crops at farmers markets.
The NDFMGA Board of Directors met to determine the wording and determinations that would define successful applicants. The ECH then devised a grant application and disseminated the call for grant proposal by new vendors via email, post card, newsletter, letter and social media. Based on the criteria set by the NDFMGA Board, the ECH received applicants and assessed their eligibility. Grants were only be awarded to new vendors at markets. This was defined as vendors who had never previously sold at any farmers market. In this way, the number of new vendors to markets could be measured. Producers receiving assistance were required to submit receipts for purchases of display and marketing items eligible under this grant and a list of eligible crops they produced and sold at the markets and/or photos of them selling their products at a farmers market to the NDFMGA. Sub-grants given with SCBGP funding for new vendor recruitment were only awarded to producers who grew and marketed eligible crops. The goal of the original proposal, to recruit 30 new vendors to North Dakota market was met. The recruitment of the 30 new vendors has allowed the participation to increase by the 30 vendors around the state. Any additional vendors were not tracked using this grant.

Goal 3: Increase the number of youth involved in specialty crop production and entrepreneurial activity in North Dakota by supplying 10 schools with Green and Growing School Garden grants. Since this was a continuation of a previous activity, the ECH met with NDFMGA Board members to update the grant application and its guidelines and then sent the call for proposals out via email list to all schools within North Dakota. Grants were awarded only to schools that had not previously been funded through this program and only for the production of curriculum and garden areas that produced eligible specialty crops. Schools needed to identify local partners and means of continuing the gardening projects once grant funds were expended. Schools needed to submit final reports regarding the successes of their ventures and learning outcomes. All Green & Growing grants for schools were awarded only to schools who specified they would be growing eligible specialty crops. The goal for this portion of the project was to fund 10 school gardens. This goal was met.

There are currently 477 K-12 schools in North Dakota. In the life of the Green and Growing grant program for schools, fifty-nine grants have been awarded. Thanks to this program, 12% of ND schools have school gardens. A survey was conducted of the previous recipients of the Green & Growing Grant. Of the 18 surveyed, 6 replied with their participation numbers. The six schools combined have a total of 408 students participating. On average, there are 68 students participating in this program per school. It can be extrapolated that 4,012 students are participating in school garden programs as funded by the Green & Growing Grant through its several year history. Prior to this project, there were an estimated 3,264 youth that were involved in specialty crop production and entrepreneurial activity. With this project, an additional 748 students have been able to participate with specialty crops, an increase of 23%. Our goal is to continue this program and continue to increase the students who have the opportunity to become involved in specialty crop production and entrepreneurial activity in North Dakota. This goal will be achieved, at least for 2014 and 2015, through the help of independent funds donated to the NDFMGA for this purpose. These funds have already been secured.

Goal 4: Incorporate feedback from market managers and vendors in updated strategic plan for the North Dakota Farmers Market and Growers Association.

The NDFMGA met to review final reports and feedback from managers, vendors and schools as a part of their strategic planning process in February of 2012 and to incorporate strategies for removing barriers or providing continued support into the Associations future projects. The updated strategic plan, based on evaluation of these grants and other Association projects is available for viewing online and now guides the Associations actions for 2013 and beyond. Based on the projects successes and the value of the program as it had been facilitated to that point, the Board decided to request an extension to continue the work, use the remaining funds in the allocation, and meet the goal numbers originally set forth in the project proposal. With the extension, the NDFMGA was able to meet its goals of 25 market managers receiving training and incorporating what they had learned into their markets planning, 30 new vendors at North Dakota markets recruited and 10 new school garden projects started. All sub-grants and training guidelines specified as a part of eligibility for the program the list of eligible crops and the necessity of grantees to attest to their compliance.

Beneficiaries

The beneficiaries of this project were the consumers and producers in approximately fifty Communities with populations from 75 people to 90,000 plus. This project encouraged consumers to eat locally grown fruits and vegetables by increasing the amount and variety available to them via their local farmers market, provided better opportunities for local producers to sell their products by aiding them in purchasing the items necessary to display and market their product, and encouraged market managers to build a recruitment plan and long range strategies for the growth of their markets.

Market Manager training was available online for any market manager within North Dakota or the region. This project provided a $400 stipend to each of 25 market managers to pay for time spent on the training as well as the time taken to complete the market plan and implement the strategies learned.

Thirty new vendors received $200 in funding each for display items through this grant to help with marketing their specialty crops at farmers markets.

Ten schools within North Dakota received $500 each in funds to begin a school garden program and thereby impact hundreds of students and their families across the state.

Lessons Learned

Through this project the NDFMGA has learned the value of assisting new vendors. Through the new vendor mini grant portion of this project, 30 new vendors with assisted in marketing their specialty crops at farmers markets throughout the state. Through surveys completed of farmers market customers in previous years, the NDFMGA learned that the number one thing desired by market shoppers was more vendors, more choices. The way to achieve this goal is to assist new vendors financially, to make it more appealing to sell their goods at a market and to educate them about the benefits of selling at a farmers market. With this project, the NDFMGA accomplished both goals by assisting new vendors with a $200 startup grant as well as by educating the market managers about the necessity of recruiting new vendors and marketing their venues to

consumers. Thirty new vendors is a significant number and one that will add value to the sales of specialty crops within our state.

The NDFMGA also learned that while online courses are a good way to assist leaners who are place bound or geographically dispersed, it may not be the most effective way to build camaraderie within a group of people. Although the completion rate for the online market managers course was within the limits of completion rates for online college courses, many managers who began the training did not use the online discussion forums to connect with others and thus felt isolated in their coursework. This feeling of isolation left them discouraged and some who began the course did not finish. As stated earlier, while this is to be expected in any online course, perhaps a better way to train market managers and to help them feel a part of a bigger picture would be to run the course as a two day weekend workshop where managers could network with others in their situation and build cohorts so the managers would be able to gain expertise and ideas from each other. Although the number of managers that would attend this format would be less (because of travel considerations) the percent of successful completions would rise. The NDFMGA will consider this form of training for future managers.

With new changes in the school lunch system and additional pressure on schools to serve more fresh fruits and vegetables, the Green and Growing school garden grant has become more popular than ever. With only 12% of schools in North Dakota having garden projects, there is room for much expansion. The NDFMGA will continue this program with funding secured from other sources.

Contact

Holly Rose Mawby
ECH Director and Executive Director for the North Dakota Famers Market and Growers Association
105 Simrall Blvd.
Bottineau, ND 58318
701-681-0252
Hollyrose.mawby@dakotacollege.edu

PROJECT 5: DEVELOPMENT OF A SEED POTATO MARKET ADVANTAGE BY DEMONSTRATING FREEDOM FROM PVY^{NTN}

Final Report

Project Summary

Certified seed potato lots were sampled from July 9 to 29, 2012 to be tested serologically for Potato virus Y (PVY) using ELISA and then with IC-RT-PCR for PVY strain identification. Serological testing took place from July 11 to July 30 and IC-RT-PCR for strain identification began July 12 and preliminary results were available October 15. The purpose of the survey was to determine the frequency of tuber necrosis strains of PVY present in the certified seed potato industry in North Dakota since it has been reported that nationwide approximately 15% of the PVY population causes this disease. A total of 591 certified seed lots were included in the survey. Two hundred leaves were sampled from each lot, except for the first field generation (G0), which had only 100 leaves sampled. There were a total of 10,206 ELISA tests performed, each serological test was performed on a composite of 10 leaves per ELISA test. Of the 591 seed lots surveyed, 80.5% had no PVY detected, while 9% had 0.5% PVY, 3% had 1% incidence of the virus, 2.9% of the lots had 1.5% PVY, 1.9% had 2% PVY, 1.9% had 2% PVY, 1.7% had 2-5% PVY and 1% of the seed lots had >5% PVY. A total of 402 IC-RT-PCR reactions were performed to identify strains. Several strains of PVY and combinations of the virus were detected using method. $PVY^{N:O}$ was the predominate strain detected with 88% of the PVY belonging to this sub-strain. PVY^{O}, which once dominated the population, now constitutes only 5% of the PVY population. The tuber necrosis strain of PVY, $PVYEU^{EU-NTN}$, was found in 3% of the samples while dual infections of these viruses were found in 2% ($PVY^{N:O}$ +PVY^{O}) and 0.75% ($PVY^{N:O}$ +PVY^{EU-NTN}) of the samples. One sample (0.25%) contained three strains of PVY ($PVY^{N:O}$ +PVY^{O}+ PVY^{EU-NTN}). Therefore, only 4% of the PVY population comprises tuber necrosis strains of PVY (PVY^{EU-NTN}).

Project Approach

Two hundred leaves from each potato field entered into certification were collected by the growers and brought to a central location for processing (ND State Seed Department, Grafton, ND and Fargo, ND). Leaf collection was coordinated by Willem Schrage, ND State Seed Department, and his staff. Sampling began the middle of July, 2012 and continued through the first two weeks of August. These leaves were crushed in buffer in composite samples of 10 leaves and serologically tested for the presence of PVY using enzyme-linked immunosorbent assay (ELISA) using manufacturers guidelines (Agdia, Inc., Elkhart, IN). Samples testing positive for PVY were forwarded to NC Gudmestad's research laboratory at NDSU where immunocapture-PCR (IC-PCR) were used to identify the strain of PVY present using PCR primers developed in his laboratory (Lorenzen, et al., 2006). Strain identification using IC-PCR continued through September and the first half of October and were performed by Ipsita Mallik (MS, Microbiology).

Goals and Outcomes Achieved

The survey of the ND certified seed industry was conducted under the auspices of the North Dakota State Seed Department, the regulatory authority for certified seed production in the state. The North Dakota Seed Potato Growers Association has unanimously voted to support this PVY survey to determine the frequency and the identity of all PVY sub-strains because they recognize the potential marketing advantage that could result if this survey demonstrated the incidence of tuber necrosis strains of PVY^{EU_NTN} and PVY^{NA_NTN} were found to be low or nil. Recent surveys conducted across the United States have demonstrated that incidence of tuber necrosis strains of PVY ranged from 14-16% from 2009-2011. The incidence of tuber necrosis strains of PVY found in ND certified seed were demonstrated to be only 4% of the population. The measureable outcome, therefore, was the quantifiable level of each strain of PVY in the ND certified seed system. Furthermore, we completed our goal by demonstrating and documenting that the level of tuber necrosis PVY strains are very low, approximately one quarter of that found in other areas of the United States.

Research results were shared at the annual meeting with approximately 20 growers, which amount to about 66% of the seed growers in the state. Those that were not at the meeting were made aware of the results by those that did attend. A summary of our findings will be published in the ND Seed Journal in the first quarter of 2013 in an article that presents the results from the winter grow out performed in Florida. This is the most appropriate format for hard copy distribution of information that provides a complete picture of the PVY situation.

The percentage of seed potato industry stakeholders being exposed to the results of this project is currently low since the project was completed recently. If the stakeholders include the commercial industry, we estimate about 30% so far have been exposed to the results. A few commercial growers (<10) have also indicated they were made aware of the results by seed potato growers. Additionally, the data was shared with the project director of a nationwide PVY project, Stewart Gray of USDA-ARS, and the results of ND were included in a recent presentation he made in Las Vegas on January 17, 2013 in which the results from the ND seed industry were compared to their overall nationwide survey of PVY substrains in all potato crops grown. These data will also be presented at our regional potato grower meetings held on February 19 and March 5. We have not had the opportunity to present all of the information to the seed growers and to the stakeholders just yet, but the winter grower meetings are just beginning. The outcomes of the work are just beginning to be disseminated.

Beneficiaries

The direct beneficiaries of this work are the potato seed producers in the state and the seed potato certification regulatory agency. Other beneficiaries are the commercial potato growers in the state and nation who are able to purchase certified seed potatoes from the state of North Dakota knowing that the incidence of tuber necrosis strains of PVY is among the lowest, if not the lowest, in the United States. There are 31 seed growers and approximately 65 commercial potato growers in the state that benefitted from this work. Also benefiting from this project are two French fry processors and three fresh potato packers.

Lessons Learned

The most significant lesson is that very productive collaborative relationships among state agencies can be established easily for the greater public good. It was also learned that detailed planning can lead to flawless execution of an experimental approach.

Contact

Neil C Gudmestad, University Distinguished Professor, Department of Plant Pathology, North Dakota State University, Fargo, ND 58108; neil.gudmestad@ndsu; office: 701 231 7547

Additional Information

More detail regarding the methodology used in these studies can be found in the following manuscript.

Mallik, I., Anderson, N.R., and Gudmestad, N.C. 2012. Detection and differentiation of *Potato virus Y* strains from potato using immunocapture multiplex RT-PCR. Am. J. Potato Res. 89:184-191.

PROJECT 6: TO ENHANCE THE COMPETITIVENESS OF SPECIALTY POTATO VARIETY MONDAK GOLD (MN15620) AND EVALUATE MULTI-STATE POTATO BREEDING LINES FOR FRENCH FRY PROCESSING, FRESH PACK AND FRESH "NICHE" SPECIALTY MARKETS

Final Report

Project Summary

This project coupled potato variety research on "niche" market multi-purpose potato cultivators/ breeding lines with mini-tuber and early generation seed potato production of the MonDak Gold potato variety. MonDak Gold is a multi-purpose red skin, yellow flesh potato variety with excellent culinary attributes and processing in making processed and fresh pack potato products from storage.

The project included newly bred specialty cultivators/ breeding lines from University of Minnesota, North Dakota State University, and the Tri-State Potato Breeding Programs in Idaho, Washington, and Oregon to identify specialty potato varieties for the fresh market with superior culinary attributes and suited for processing for superiority over the industry standards in making specialty and traditional potato products.

MonDak Gold has the potential to extend the marketing period of potatoes produced by two months due to its resistance to sugar sweetening at low temperature storage, and produce golden yellow French fries without the dark sugar ends of many potato varieties. In testing market quality, MonDak Gold potatoes show excellent promise in the fresh pack, French fry, roasting, chips, niche, and traditional markets. MonDak Gold potatoes produced both lower acrylamides and reducing sugars than the industry standard Russet Burbank variety.

The project has served as a catalyst for innovative potato products and uses to encourage the expansion of potato production and markets for Northern Plains growers, to attract new interest by potato processors and fresh pack companies in the MonDak region, and to deliver positive nutritional messages about potatoes to the trade and consumers. The disease free mini-tuber and MonDak Gold seed potato production in this project will provide MonDak Gold seed potatoes for commercial production and expanded test marketing.

The commercial production and expanded test marketing for new and innovative potato products in the processing and fresh market industries is the next step in bringing this new MonDak Gold potato variety to the market place. The potato industry is ever changing and consumers are looking for innovative potato attributes to deliver positive nutritional messages about potatoes to consumers.

As these specialty markets are fully developed, the MonDak Gold potato variety will not only improve the profitability for potato producers, but stimulate new potato production, processing, and create new sustainable economic wealth through growth of the potato industries in the MonDak region.

Project Approach

The Williston Ag Diversification Group (WADG) participated in the 2012 National Potato Council Expo and Trade Show held January 6-7, 2012 in Orlando, Florida. Chuck Stadick, Potato Consultant and Christian Thill, University of Minnesota potato breeder, represented our Group to promote the production and marketing of the MonDak Gold potato variety and other promising niche potato breeding lines being tested and evaluated for specialty markets for roasted, table stock, fry processing, and other end uses.

Several seed growers expressed interest in growing the MonDak Gold potato variety upon availability. An organic potato company expressed great interest in MonDak Gold and representatives from all the major potato processing companies stopped by the WADG booth and asked when the variety would be available for full scale testing. Wendy's potato buyer met with Chuck Stadick during the Trade Show regarding MonDak Gold potatoes and other opportunities with their company. Companies that have done limited testing of MonDak Gold potatoes include J.R. Simplot, Ore-Ida, the fresh pack company Ryan Potato Company (now RDO Farms), and Cavendish Farms.

Overall, MonDak Gold potatoes matched or exceeded the standard Russett Burbank variety in the Sensory Taste Committee test results (see attachment 1). Contracts were signed with Valley Tissue Culture, Halstead, Minnesota for production of mini-tubers and with Enander Seed Farm, Grenora, North Dakota for the grow out of mini-tubers to Generation 0 and to Generation 1. Plantings and evaluations were conducted on the "niche" market potato breeding lines/varieties grown at the Williston Research Extension Center Nesson Irrigation test site 23 miles northeast of Williston by Dr. Christian Thill, University of Minnesota, and Dr. Susie Thompson, North Dakota State University. Results of the most promising advanced specialty breeding lines from the strip trial in Nesson Valley are shown in Table 1 and Table 2.

MonDak Gold potato variety and 30 other niche market potato breeding lines were also planted May 1-2, 2012 and grown in the Nesson Valley Research and Development project near Ray, ND. The potato breeding lines were tested for yield, agronomic characteristics, disease evaluations, storability, grading and fry, roast, and fresh market quality factors. The Enander Seed Farm planted 0.4 acres of Generation 0 and 1.44 acres of Generation 1 MonDak Gold variety potatoes on May 12th and May 21st respectively.

Valley Tissue Culture in Halsted, MD produced 575 pounds of mini-tubers of MonDak Gold potatoes in their greenhouse facility for Enander Seed Farm grow out of the Generation 0 MonDak Gold seed potatoes in 2013. Mr. Stadick visited with commercial producers for plans for future commercial production of MonDak Gold potatoes in 2013. Mr. Stadick reviewed the plans to test market MonDak Gold with the J.R. Simplot Tech Center, Ore-Ida Foods, Cavendish Farms, and others.

The MonDak Ag Showcase events were held July 24-25, 2012 in the Williston, ND area under the planning and scheduling by the Williston Area Ag Diversification Group and included field days, tours, and seminars showcasing the potato project. On September 20th, the Williston Research Extension Center hosted an evening meal at the WREC Ernie French Center for potato

researchers, potato consultants, community leaders, economic developers, and infrastructure investors.

Potato growers, French fry processors, restaurant owners and chefs, fresh potato market suppliers, organic producers, the general public/ consumers, and an estimated 300 stakeholders participated in these events.

The forum gave the opportunity for Rick Fisch, a consultant for a potato processing plant investor group, to report that the Williston area is currently ranked as one of the top two choices for a new potato French fry processing plant. The Enander Seed Farm Generation 0 and Generation 1 MonDak Gold variety potatoes were harvested on September 21, 2012. Both seed production fields passed certified seed field inspections and the yields were very satisfactory. Potato harvest of the potato breeding lines and strip trials was accomplished October 2-4, 2012.

Mr. Stadick inspected and observed the seed storage operations at the Enander Seed Farm to confirm that sanitary methods were in place for proper seed storage of the MonDak Gold potatoes and also confirmed that additional mini-tuber production of MonDak Gold at the Valley Tissue Culture greenhouse facility in Halsted, MN was progressing well. Mr. Stadick also contacted the industry testing facilities after the MonDak Gold potatoes were harvested for shipping samples of MonDak Gold potatoes for test marketing purposes.

Samples were shipped to all processors for testing in December 2012. The Williston Ag Diversification Group (WADG) participated in the 2013 National Potato Council Expo and Trade Show held January 8-11, 2013 in Las Vegas, NV. Chuck Stadick, Potato Consultant, Jerald Bergman, President, WADG, Christian Thill and Jeff Miller, University of Minnesota, Dr. Susie Thompson, North Dakota State University, and Tom Rolfstad, Director of the Williston Area Economic Development Foundation represented WADG to promote the production and marketing of MonDak Gold and other promising specialty potato breeding lines tested and under evaluation for specialty markets for roasted, table stock, fry processing, and other specialty potato products.

A WADG booth displayed MonDak Gold with informational materials describing agronomies, nutrition, storability at low temperatures, reducing sugar resistance and low acrylamides. Chocolate covered MonDak Gold potato chips were also displayed for customers to sample (see attachment 2). This product was very popular at the show and is a potential new market outlet for MonDak Gold potatoes. The ripple cut produced more potato flavor than the traditional thin chip cut. Industry cutting systems will be investigated for an appropriate ripple cutter for this product.

The WADG met potential commercial and seed growers from Idaho and Washington State interested in moving or expanding potato operations to the MonDak region. Both the Idaho and Washington state growers are interested in building a fresh pack operation in the MonDak region to service grocery outlets and restaurant businesses. Potato Consultant Chuck Stadick arranged for MonDak Gold potato testing in Ore-Ida's research kitchens. Christian Thill met with Cavendish Farms processors on the MonDak Gold field tests which repeatedly showed good

agronomic traits and outperformed Russet Burbanks for processing and were evaluated for new frozen products.

A Nebraska seed grower met with WADG and is interested in growing and storing MonDak Gold Generation seed potatoes in 2013. This seed grower will be a key to producing and supplying seed potatoes to commercial growers for expanded test marketing to prospective buyers for sensory and quality evaluation in their business environments. The evaluation and analyses of specialty potato breeding line samples from the 2012 Nesson Valley site were completed by Jeff Miller, University of Minnesota Potato Scientist and Dr. Susie Thompson, NDSU Potato Breeder in February, 2013.

The Nesson Valley potato variety trial and strip trial results were published in the proceedings of the 2013 Potato Research Reporting Conference held February 19-20, 2013 in Grand Forks, ND. Promising advanced lines include MN02467 and MN1874 for fry processing, MN02586 and MN04844-07 for fresh yellow markets, MN0216 for fresh red markets and MN07112 for novelty white/purple cream colored potato chip. NDSU promising advanced breeding lines for processing included russets ND8624, ND8625, ND97279-5, and AND00618-2.

Goals and Outcomes Achieved

Newly bred "niche" market potato breeding lines and advanced potato breeding lines were planted, harvested, and evaluated in 2012-2013 and published in the proceedings of the 2013 Potato Research Conference, February 19-20, 2013, Grand Forks, ND. Newly developed multi-purpose advanced potato breeding lines including MonDak Gold potatoes were identified that met or exceeded industry standards for processing and specialty market uses.

MonDak Gold potatoes were test marketed in the processing and fresh market industries with "niche" market opportunities in French fry processing with lower acrylamides and greater resistance to sugar ends than Russet Burbanks. Interest in the fresh pack industries was created at the 2012-2013 National Potato Council Expo and Trade Shows held in Orlando, Florida (January 2012) and in Las Vegas, Nevada (January 2013).

Valley Tissue Culture produced 575 pounds of mini-tubers for subsequent distribution to the Enander Seed Farm to meet our target of 500 pounds of mini-tubers. The Enander Seed Farm successfully produced 480 cwt of Generation 1 MonDak Gold seed potatoes in 2012 to provide seed potatoes for Generation 2 seed growers to replant as seed for commercial growers in 2014 and to utilize for "niche" market testing in 2014.

Beneficiaries

This project serves as a catalyst for innovative potato varieties, potato products, and uses to deliver positive nutritional message about potatoes to the trade and consumers and to interest and attract potato processors and fresh pack operations to the MonDak region. This project has created a nucleus of MonDak Gold virus free mini-tubers, and Generation 0 and Generation 1 seed to provide more seed potatoes (Generation 2) in 2013, to test marketing, and seed to commercial growers for 2014.

The impact of "niche" markets will be realized by how fast and what quantities the MonDak Gold and potential other breeding lines replace existing standard varieties because of their superior fry, roasting, fresh market, and specialty potato qualities. "Niche" processing and fresh market opportunities of MonDak Gold potatoes will expand the MonDak Gold commercial production and help diversify the MonDak agricultural region into a major irrigated potato producing area.

These representatives from a multiple of organizations benefited by the potential to produce, supply, and market MonDak Gold potatoes and the advanced multi-state potato breeding lines for French fry processing, fresh pack, and fresh "niche" specialty markets:
Rural Economic Development, Glendive, MT, Ben Holmes Potato Fresh Pak Company, J. R. Simplot Co. Food Division, Hutterite Bretheran Farms, Warden, WA., Cavendish Farms., Schillington Farms, Twin Falls, ID., Northern Plains Potato Growers Assoc., Grand Forks, ND., Countrywide Potato, Alliance, NE., Potato Grower Magazine, Idaho Falls, ID., Fresh Select Produce, Idaho Falls, ID., ConAgra Foods Lamb Weston, Kennewick, WA., Enander's Seed Farm, Grenora, ND., New Sprout Organic Farms, Asheville, NC., SunRain Potato, Idaho Falls, ID., Grower Tiede Farms, American Falls, ID, Schutter Seed Farm, Manhattan, MT., Harvest Fresh Produce, Pasco, WA., Moss Farms, Declo, ID., Flying H Farms, Mountain Home, ID., Christensen Farms, Melba, ID., Hanks Farms, St. Anthony, ID., Toevs Farms, Aberdeen, ID., Black Gold Farms, Grand Forks, ND, North Dakota Dept. of Commerce, Bismarck, ND, Schroder Potato Farm, Bill Sheldon Potato Farm, Agri Industries, Williston, ND, North Dakota Irrigation Association, Bismarck, ND , Williston Regional Economic Development Corporation, Williston, ND , Cashwise Grocery Store, Williston, ND, The Williston Restaurant, Williston, ND, Black Gold, man camp, Williston, ND, Williams County Extension, Williston, ND , Divide County Extension, Crosby, ND, McKenzie County Extension, Watford, ND, Mountrail County Extension, Stanley, ND, Dawson County MT Extension, Glendive, MT, and home gardeners. There is an estimated 300 beneficiaries from this project.

Lessons Learned

This project is an extensive collaborative effort of the potato research programs at the University of Minnesota and North Dakota State University Breeding Programs and the North Dakota State University Williston Research Extension Center with the Williston Area Ag Diversification Group, Chuck Stadick, Spud Viking Potato Consulting, and the Northern Plains Potato Organization provided much valuable assistance. All these organizations and individuals working together conducting potato research and varietal test marketing and promotion of MonDak Gold and other advanced specialty potato breeding lines nationwide.

This project helped develop and promote these newly developed (developing) cultivators for specialty markets and adaptation to the MonDak and Northern Plains region. Valley Tissue Culture, Halsted, MN and Enander Seed Farm, Grenora, ND played a major role in the positive outcomes of a supply of MonDak Gold certified seed for commercial production and test marketing for processing into fries, chips, fresh market, baking, mashing, roasting, and microwave cooking products.

Contact

Dr. Jerald Bergman, President, WADG
Telephone: 701-774-4315 (office) 701-770-0933 (cell)
Email Address: Jerald.bergman@ndsu.edu

Additional Information

Attachments:

Table 1
2012 University of Minnesota & North Dakota State Univeristy Specialty Advanced Potato Breeding Lines
2012 Williston, ND Nesson Valley

					Tuber Size													
					≥ 4 < 6 oz		≥ 6 < 8 oz		≥ 8 < 10 oz		≥ 10 < 12 oz		≥ 12 < 14 oz		≥ 14 oz		Total All3 Yld	
Breeding Line	Mkt*	Skn	Flesh	Rep	cnt	Cwtyld	cnt	Cwtyld	cnt	Cwtyld	cnt	Cwtyld	cnt	Cwtyld	cnt	Cwtyld	cnt	Cwtyld
MonDak Gold	FF/FM/C	Red	Yellow	1	201	45.3	100	31.6	85	34.1	39	19.5	23	13.4	30	22.6	478	166.6
MN02467	FF/FM	Russett	Yellow	1	120	54.1	104	66.5	64	51.3	50	49.4	35	41.3	31	48.4	404	311.0
MN02586	FM/C	White	Yellow	1	365	162.0	105	64.1	26	20.8	8	7.8	1	1.2	0	0.0	505	255.9
MN07112	FM	White/Purple	Purple/White	1	193	82.1	39	24.7	8	6.3	2	2.0	0	0.0	0	0.0	242	115.1
MN04844-07	FM/C	White	Yellow	1	546	88.1	163	37.3	47	13.7	4	1.4	1	0.4	1	0.5	762	141.4
ND8625	FF/FM	Russett	Cream	1	302	69.0	256	81.1	193	77.9	93	46.2	35	20.3	19	13.7	898	308.0
ND8624	FF/FM	Russett	Cream	1	356	80.3	291	91.1	152	61.4	57	28.0	29	16.9	4	3.0	889	280.7
ND97279	FF/FM	Russett	Cream	1	381	86.1	248	78.1	106	42.3	50	24.5	19	11.0	9	6.3	813	248.4
AND00618	FF/FM	Russett	Yellow	1	156	35.0	120	38.0	115	46.3	74	36.4	46	27.1	46	35.3	557	218.2

* FF-French Fry
* FM- Fresh Market
* C- Chips

Table 2
2012 University of Minnesota & North Dakota State University Specialty Advanced Potato Breeding LInes
2012 Williston, ND Nesson Valley
Planted: May 1-2, 2012 Harvested: October 2, 2012

Note: Potatoes stored at 40° F

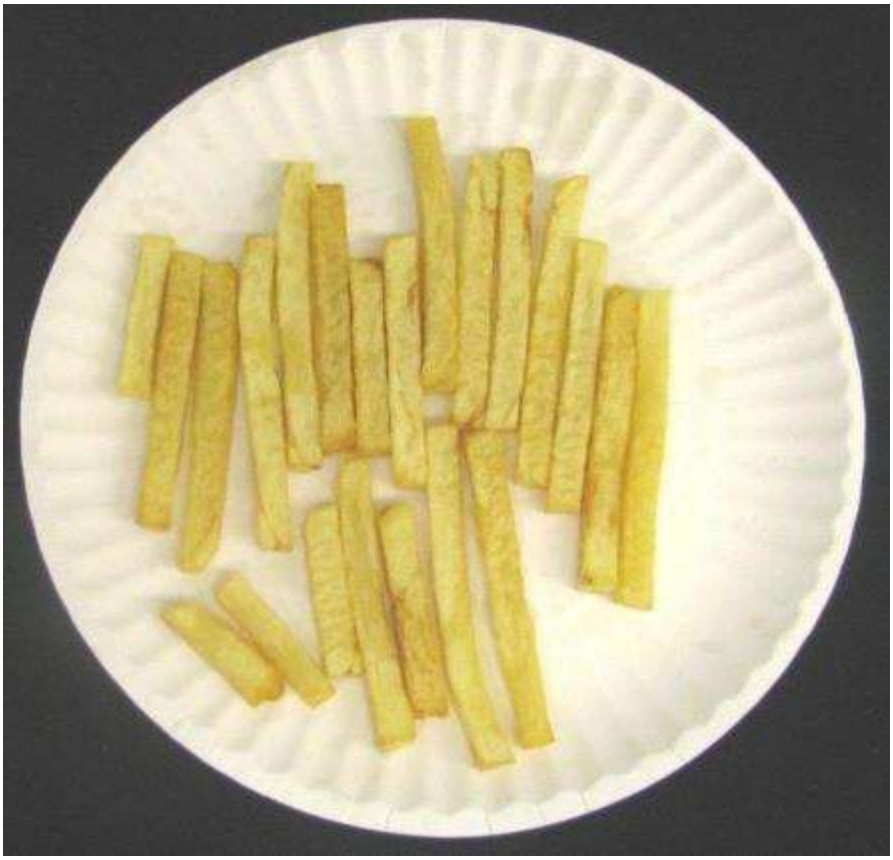
Breeding Line	Mkt*	Skn	Flesh	Sp Gr	Internal Defects (%) Hollow Heart	Notes
MonDak Gold	FF/FM/C	Red	Yellow	1.092	0.00%	Beautiful unblanced yellow French Fry; NO Sugar Ends
MN02467	FF/FM	Russett	Yellow	1.091	16.70%	
MN02586	FM/C	White	Yellow	1.092	16.70%	Yellow chip
MN07112	FM	White/Purple	Purple/White	1.081	0.00%	
MN04844-07	FM/C	White	Yellow	1.081	16.70%	Yellow chip
ND8625	FF/FM	Russett	Cream	1.074	0.00%	
ND8624	FF/FM	Russett	Cream	1.081	0.00%	
ND97279	FF/FM	Russett	Cream	1.090	33.30%	
AND00618	FF/FM	Russett	Yellow	1.077	50%	Nice unblanched yellow French Fry

MonDak Gold French Fries
Blanched 8 min @ 180F
Fried 3 min @ 365F

* FF-French Fry
* FM- Fresh Market
* C- Chips

Variety Strip Trial, NDSU Williston Research Extension Center, Nesson Valley

MonDak Gold Chocolate Chips



MonDak Gold French Fries

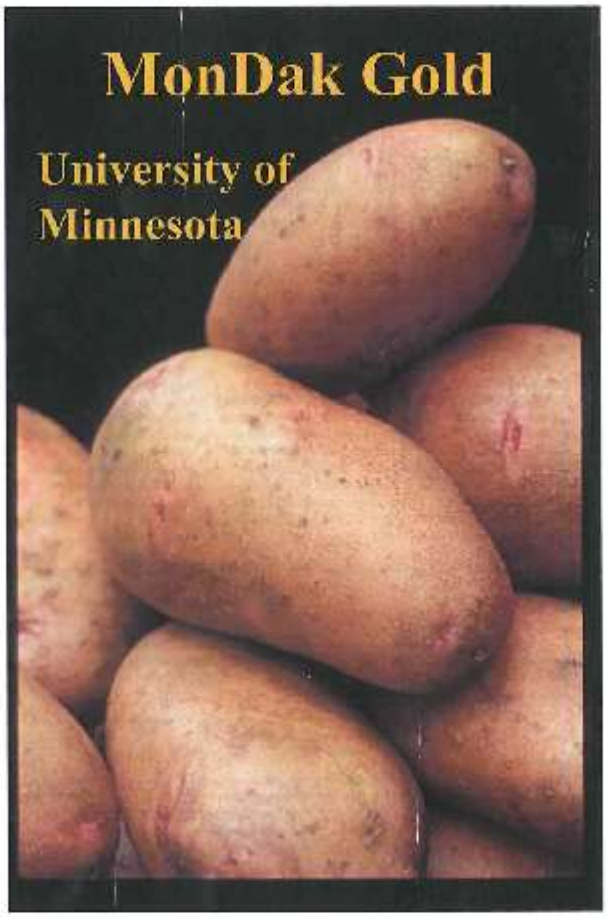
MonDak Gold Potato Strip, Bill Sheldon Farm, Ray, ND

MonDak Gold Seed Potatoes, Enander Seed Farm

Chuck Stadick, Spud Viking, and Corrie Enander , Enander Seed Farm Inspecting MonDak Gold Potato Seed Field at Enander Seed Farm.

MonDak Gold Potato Chips

Variety Strip Trial, NDSU Williston Research Extension Center Nesson Valley


MonDak Gold
University of
Minnesota

PROJECT 7: NORTHERN HARDY FRUIT EVALUATION PROJECT

Final Report

Project Summary

Many years ago, NDSU removed all tree and shrub fruit research from the Department of Plant Sciences. This was not unlike the situation at other universities. In conversations with people utilizing Carrington Research Extension Center's (CREC) services, it was clear that there was a great desire by the public to learn more about fruit plants that were hardy in North Dakota. Catalog descriptions are often inadequate or inaccurate in describing the suitability of plants for our region.

People, and the USDA itself, are embracing community supported agriculture (CSA), community gardens and farmers' markets, showing that they will support local food systems and try fruits and vegetables not usually available through conventional markets. Requests for information about alternative fruit crops led to the establishment of a multiple-year demonstration and variety trial of northern-hardy fruits at CREC in 2006. CREC is evaluating fruits that are underutilized yet are well known and desired in other parts of the country or world in order to introduce local growers, processors and consumers to unfamiliar yet healthy and delicious fruits which can be easily grown in North Dakota. It is the mission of CREC to utilize its landbase to provide knowledge that creates economic opportunities for all North Dakotans. To this end, CREC has subsidized the Fruit Project by internal reallocation of funds from multiple sources when grant funding has not been available.

The Northern Hardy Fruit Evaluation Project is the only known research-based project that is determining the suitability of selected cultivars of northern-hardy fruits for both home gardeners and commercial production in the upper Great Plains or Midwest. The plants in our study are hardy, adapted to our climate and soils, easy to grow and produce fruits high in phytonutrients and antioxidants – shown by research to be important to human health.

This USDA-SCBGP grant continued the work of the previous grant (same title, 2010-11). Woody fruit species require three to five years of establishment before producing fruit; therefore, even at this point, we are just beginning to establish the long-term production records needed by potential growers. We continue outreach activities with the public and contacts with local fruit processors. The grant travel funds allowed an excellent speaker to address the attendees at our annual Field Day. The survey funded by this project shows that the Fruit Project has had a powerful impact on the number of fruit plants grown in North Dakota.

Project Approach

Hardy Fruits: After spring pruning, general management of the fruit trial takes up much of the rest of the season as we mulch, fertilize, mow and control weeds. In order to evaluate each fruit crop for adaptation, disease resistance, winter hardiness, productivity, fruit quality and vinification quality under central North Dakota growing conditions, we take notes on diseases, insect damage, growth and vigor both during the growing season and in the fall. *(Appendix 1, measurements)* Fruit production is evaluated by harvesting and measuring the amount of fruit produced. *(Appendix 2, harvest weights)* After freezing, the fruit is distributed to cooperators and the project manager also prepares jellies, jams and juices for meeting participants to taste. In fall, management includes cleaning up fallen leaves, mowing the grass short and removing the

clippings, setting out rodent bait near plants susceptible to damage, as well as thinning extra-vigorous grape plants to prevent winter snow-load damage. Winter work includes data entry and examination as well as making presentations around the state.

In general, the plants selected for the project grow well, are winter hardy, disease free and many have excellent fruits. They have been well-received by visitors and processors who have tried the fruits. We evaluate growth and harvest notes to make decisions about plants that should be removed to make way for better or different fruit selections.

Due to our outreach efforts, approximately 80 people joined the fruit project tour and tasted ripe or semi-ripe fruit at the annual field day event hosted by CREC on July 17, 2012. This grant funded retired consumer horticulture educator and Juneberry Extension specialist with Michigan State University, Steve Fouch, to speak at the event. He not only discussed Juneberries in the field, but later presented information regarding market development and farm-experience marketing regarding a centennial farm that features a professional corn maze, farm market, U-pick Juneberries, red raspberries and a variety of fruit trees. On the second day, Mr. Fouch made site visits to families interested in starting their own farm enterprises. His presence and USDA funding was much appreciated.

Partners: a.) Six North Dakota cooperators utilized fruit from the project in 2011-12. (This is double the number of cooperators in the last grant period.) Three vintners made wines from aronia berries, honeyberries, haskaps, black currants, red and white currants, and cherries. Two jelly makers made new jams from honeyberries and aronia as well as a familiar jam from Juneberries. And one kuchen-maker tried and liked both aronia and honeyberries. The manufacturers have been happy with the fruit, and each has said "we will buy all you have." b.) The fruit project assisted a member of the North Dakota Grape Growers Association in his efforts to bring new, hardy cherry and haskap plant varieties to North Dakota from Canada. While the organization and ordering effort was his, the fruit project manager assisted with variety recommendations, contacts and plant distribution. In 2012, 1,060 plants were purchased by participants. Including the two previous plant buys, over 6,100 hardy cherry and haskap plants were bought and planted by people who learned about these plants from the fruit project; in several years, these plants could produce over 70,000 pounds of fruits!

Grapes: We have continued to use methods to lower soil nitrogen and reduce overall grape plant vigor in order to encourage more normal growth and to bring our grape varieties into bearing. This practice was implemented in the first grant and continued with this one.

Winter 2011-12 was open, dry and warm. Seventeen of 18 grape varieties had enough bud survival to produce fruit. Due to our previous austerity measures, growth has moderated on all except two or three varieties. With a long growing season in 2012, dry weather and fruit production, almost all varieties began to harden their canes in preparation for winter. Rain prior to freeze-up moistened the soil and should allow the grapes to overwinter, grow in a normal fashion and again produce fruits in 2013.

Harvest data has not been collected for grapes to date. Production has been spotty, at best, and the fruit has struggled to fully ripen prior to freeze. We have not netted the plants and so birds have eaten most of the crop by the end of the season.

The final year of research as to whether grow tubes help in grape plant establishment was completed. All of the data has not been completely analyzed; however initial results do not seem to show that tubes greatly assist in plant establishment but are helpful for management during the growing season.

Goals and Outcomes Achieved

Outcome: Initial variety recommendations will be prepared.

1. *Goal:* Hardy, adapted cultivars with good fruit quality and production are identified.
2. *Performance Measure:* Varieties will be judged on winter hardiness, disease resistance, production capability and consistency, flavor and processing attributes.
3. *Benchmark:* Variety attributes are measured to be consistently superior and processors notice a difference between samples.
4. *Target:* Ten to 20 varieties will be cited as superior choices for North Dakota.

RESULTS: We identified 37 cultivars which are recommended for growth and production of fruit in North Dakota. Eight apple and plum cultivars are recommended with reservations, primarily because they need more time for evaluations. Twenty-nine cultivars are wholly recommended, which is greater than the 10-20 we had estimated would be selected as superior. We have prepared a handout with these recommendations (see attached). It is distributed at presentations and is available on our website. www.ag.ndsu.edu/CarringtonREC

Outcome: A greater variety and number of hardy fruiting shrubs, trees and grapes has been planted across North Dakota by homeowners or commercial operations.

1. *Goal:* The public will utilize the results of the CREC fruit project in making new planting decisions.
2. *Performance Measure:* The number of fruiting plants established will have increased.
3. *Benchmark:* By survey, determination of the number of fruiting plants 5 years earlier.
4. *Target:* A measurable increase in the number and variety of fruiting plants established since 2007.

RESULTS: In our original proposal, USDA requested that we estimate the original numbers of fruit plants in North Dakota and the new numbers after 5 years of project work. We estimated very low on our initial numbers of fruit plants five years ago (200 plants), but through our survey, we have seen that the numbers of fruits planted still increased significantly.

The survey results from 69 respondents shows that five years ago, 32% did NOT grow fruit while today, only 3% don't grow fruit. Five years ago, respondents grew an estimated 2,200-3,100 fruit plants while today the number is estimated to be 8,000-10,000 fruit plants. (In the category 'more than 100' or 'more than 200 fruit plants', exact numbers were used when provided; if an exact number was not provided, the number 100 or 200 was used in the calculations.) This is calculated as an average 241% increase in the number of fruit plants grown by respondents, and we believe these numbers are reflective of most Fruit Project participants. 82% of respondents indicate that they will be planting more fruits in the future. (Please see attached survey results.)

For some questions, respondents had the opportunity to make more detailed responses (e.g.: plants types, plant numbers). These answers are attached after the survey and their numbering refers back to the original question number.

Outcome: Established food and wine companies in North Dakota will utilize CREC fruit to develop new products and then either grow the fruit themselves or buy it from North Dakota growers. Two bakeries, eight wineries and eight jam/jelly/syrup makers who are Pride of Dakota members have been identified as businesses that use fruit in North Dakota.

1. *Goal:* To make these 18 businesses aware of the new fruits at CREC.
2. *Performance Measure:* The number of businesses that express a desire to put new products into production.
3. *Benchmark:* In 2010, three businesses utilized CREC fruit for wine.
4. *Target:* Three to five additional businesses will express a desire to utilize these fruits in 2011.

RESULTS: We met our goal in that all 18 Pride of Dakota (PoD) businesses received letters and follow-up emails regarding the availability of fruit from the Fruit Project. Three additional PoD businesses used project fruit in 2011-12, for a total of six fruit cooperators in North Dakota. Each business indicates that they would like to 'buy all we have' of each of the fruits they are interested in. Currently, three wineries, two jelly makers and one kuchen maker utilize our fruit. (See also: 'Partners', page 2)

Outcome: Grape plants at CREC will have a normal cycle of bearing fruit and become winter hardy.

1. *Goal:* To utilize methods for growing grapes in highly fertile soils to bring CREC grape plants into a normal cycle of bearing fruit and being winter hardy.
2. *Performance Measure:* The hardiest plants will survive the winter and produce fruit.
3. *Benchmark:* To date, only three varieties have fruit-bearing plants.
4. *Target:* Seven to ten other hardy varieties will start producing fruit in the next year.

RESULTS: Despite a hard freeze that killed buds in April 2012, 17 of 18 varieties of grapes produced fruit. This was really above our target total of 10-13 productive grape plants. We have continued to use methods to lower soil nitrogen and reduce overall grape plant vigor and this is proving to be very successful at our site. Plants were lignifying canes (canes were becoming woody) in late summer, a sign of normal growth. With good winter weather we should again see fruiting success in 2013.

Despite this success, the hardy varieties we are growing still may not fully ripen in our climate. Only one purple grape, 'Valiant', one table grape 'Somerset Seedless', and several white grapes 'Brianna', 'ES 8-2-43' and 'Prairie Star' lower their acidity reliably in our area of North Dakota.

Beneficiaries

We would like to especially note how well the Fruit Project has accomplished our secondary objective of making the public and commercial enterprises in our state *and area* aware of the opportunities presented by these fruits. During the 2012 grant period, 694 people participated in outreach activities where information about the fruit project was presented. A similar USDA grant was also present in fall 2010-2011 when over 700 people expanded their views of hardy fruit production. Project-long outreach is shown in the table below. Note that 2,201 people have had contact with our Project.

	2006	2007	2008	2009	2010	2011	2012	Totals
Field Day	- -	- -	- -	- -	65	80	80	225
Other Tours	- -	25	45	100	52	45	55	322
Calls and Emails	- -	- -	- -	- -	25	75	95	195
Individual Visits	- -	- -	15	50	65	15	10	155
Speaking	- -	- -	- -	- -	358	492	454	1304
Totals		**25**	**60**	**150**	**565**	**707**	**694**	**2201**

To the left is a diagram that indicates places in states other than North Dakota where calls and emails originated in 2012. Several magazine and newspaper articles have contributed to our regional recognition, as well as our website.

Total calls and emails approached 100 in 2012.

The beneficiaries of this project are North Dakotans who will grow fruit plants:

- for their own use
- to produce commercial wine
- to sell the fruit to others
- to make other commercial products such as jellies and juices.

Of the companies that used Project fruit in their products, all indicated that they would like to use the fruit again, and they would like more of it. Wine makers used: Aronia, haskaps and honeyberries, red and white currants, black currants, and cherries. Jelly makers used Juneberries, haskaps and aronia berries. The kuchen maker tried and likes honeyberries and aronia. Several companies have planted their own fruit orchards.

Members of the North Dakota Grape Growers Association have learned about the project from the fruit project manager at each annual meeting since 2007. Fifty to 100 people have attended annual meetings each year. Of 12 member wineries, three are devoted entirely, or with a majority of their production, to fruit wines.

Lessons Learned

There are nine things that the fruit project manager has observed in past six years:

1. Grapes require a lot of attention during the growing season when grown on productive soils. The typical 'rules' for vine management must be adapted for these soils.
2. In these same soils, fruit shrubs require almost no attention during the growing season.
3. However, people starting wineries are enamored by the 'romance of the grape' and seem to feel that they alone, of all who have grown the cultivars currently available for North Dakota, will succeed where others have struggled. This is human nature.
4. The fruit project manager is biased toward other hardy fruits because she has tasted really well-made fruit wines and has experienced many struggles growing and ripening grapes at our site. It is really hard to make a year-to-year consistently-good wine from grapes grown in our far northern climate. *Grape breeding projects are necessary.*
5. All fruit crops, including grapes, require dedication and a labor force at harvest. Berries take significantly more effort to harvest than grapes.
6. Individuals are really excited and interested in our hardy fruit plants.
7. It is more difficult to interest processors in new fruits because they don't know if customers will embrace them.
8. Diverse fruit crops spread out the blossom and harvest seasons to lower risk of crop failure due to weather events.
9. Weather 'events' are guaranteed.
    a. 2010 was very cool. Grapes did not fully ripen.
    b. 2011 was very wet until it quit raining in late summer.
    c. 2012 continued to be dry with an odd, warm winter that damaged fruit crops across the nation. CREC hardy fruit crops were OK, except for black currants which partly froze in April, but still produced a crop on some varieties.

With no processing facilities, cold storage or reliable labor source in North Dakota, it is difficult to expect a large fruit production system to appear quickly in our state. There have been people who have contacted me, excited to grow fruits on large acreage – but when I describe the labor required or capital needed to purchase a picker, they are less enthusiastic.

However, in just the last month, I learned about three new u-pick orchards that were planted around the state. (In last year's report, several other aronia and haskap orchards had been started for winemaking.) There are surely more that I do not know about. This is an excellent start and vindication of our hard work! We appreciated your support.

Contact

Kathy Wiederholt
Fruit Project Manager
NDSU - Carrington Research Extension Center
663 Hwy. 281 NE; PO Box 219
Carrington, ND 58421-0219
Phone: 701.652.2951
Kathy.Wiederholt@ndsu.edu

Additional Information

Northern Hardy Fruit Evaluation Project - 2012 **Carrington**

Type of Plant	Cultivar Name	Number of plants	Year Planted	Ave Height	Ave Canopy Width	Vigor	Fruit Set	Harvest Date	Weight of Fruit	Ave. Wt of 10 berries	Brix	Rust	Powdery Mildew	Aphids	Disease	Insect Damage	Note
				cm	cm	0-5	yes/- -		gm	gm	% solids = % sugars	0-3	0-3	0-3	0-3	0-3	
					Trunk Caliper mm												
Apples - *Malus domestica*																	
	Haralred	2	2006	- -	60	4.0	Y	10-10	- -	- -	- -	- -	- -	- -	- -	- -	*HR:Allowed small crop*
	Haralred	2	2008	- -	48	3.0	Y	10-10	- -	- -	- -	- -	- -	- -	- -	- -	*Most apples removed*
	Hazen	4	2006	- -	84	4.8	Y	9-13	- -	- -	- -	- -	- -	- -	- -	- -	Medium crop, good apples
	Sweet Sixteen	4	2006	- -	88	5.0	Y	9-21	- -	- -	- -	- -	- -	- -	- -	- -	Few on one tree
	Honey Crisp	6	2006	- -	80	4.8	Y	9-21	- -	- -	- -	- -	- -	- -	- -	- -	Small crop, good apples
	Zestar	4	2007	- -	49	4.0	Y	9-14	- -	- -	- -	- -	- -	- -	- -	- -	Few on one tree
Aronia - *Aronia melanocarpa*																	
	Nero	4	2007	160	186	5.0	Y	8/22-24	12988	9.7	17.6	- -	- -	- -	- -	1	*Leaves lightly skeletonized*
	Raintree Select	4	2007	163	186	5.0	Y	8/22-24	18687	10.1	16.2	- -	- -	- -	- -	1	*by pear sawfly larvae.*
	Raintree Seedling	4	2007	143	189	5.0	Y	8/22-24	13145	9.4	17.0	- -	- -	- -	- -	1	*Also, lacebugs on undersides.*
	Viking	4	2007	151	187	4.8	Y	8/22-24	17995	10.4	16.8	- -	- -	- -	- -	1	*Both controlled w/ spinosad.*
	McKenzie	4	2010	83	100	4.8	Y	8-24	173	10.6	18.7	- -	- -	- -	- -	1	
Dwarf Hardy Cherry - *P. cerasus* x *P. fruiticosa*																	
	Carmine Jewel	12	2007	229	Fills 5' space	4.8	Y	7/10-11	62459	35.9	13.4	- -	- -	- -	- -	- -	*Fruit ripened fast due to*
	Crimson Passion	11	2007	198	Fills 5' space	4.3	Y	7/10-12	42981	56.0	15.6	- -	- -	- -	- -	- -	*very warm weather.*
Black Currants - *Ribes nigrum*																	
	Ben Lomand	4	2008	103	156	5.0	Y	7/23-25	5895	11.1		1.0	0	- -	- -	- -	Best flavor
	Blackcomb	4	2011	95	93	4.3	Y	- -	- -	- -		0	0	- -	- -	- -	
	Champion	4	2008	91	140	5.0	Y	7-23	1655	7.2		2.3	0	- -	- -	- -	
	Crandall *	4	2007	137	192	4.8	Y	- -	- -	- -		0	0	- -	- -	- -	ight crop. Ripens unevenly
	Minaj Smyriou	4	2008	96	146	4.8	Y	7-24	8323	12.3		0	0	- -	- -	- -	Good crop after freeze.
	Black Down WF	5	2007	101	151	4.8	Y	7-24	2551	10.4		1.4	0	- -	- -	- -	
	Black Down OGW	11	2007	105	151	5.0	Y	7-24	5926	10.2		1.1	0	- -	- -	- -	
	Hilltop Baldwin	16	2008	98	136	4.8	Y	7-24	1310	9.4		2.4	0.1	- -	- -	- -	
	Swedish Black	14	2007	73	124	4.5	Y	7-24	205	11.9		1.0	0	- -	- -	- -	Worst freeze damage.
	Titania	16	2007	120	189	4.9	Y	7-24	26656	11.8		0	0	- -	- -	- -	Best crop of trial.
	Whistler	12	2011	87	100	4.3	Y	- -	- -	- -		0	0	- -	- -	- -	New 2011
	* *Ribes odoratum*. A mild, sweeter N. American currant that ripens unevenly in September.																
Red Currants - *Ribes rubrum*																	
	Jhonkheer Van Tets	4	2008	116	149	5.0	Y	7-16	16032	7.4	10.9	0	0	- -	- -	- -	
	Red Lake	4	2007	114	135	4.3	Y	7/23-27	10810	4.7	10.7	0	0	- -	- -	- -	
	Redstart	4	2007	94	122	3.8	Y	7-30	9143	5.2	10.0	0.5	0	- -	- -	- -	Berries are more sparse.
	Rosetta	4	2007	115	148	4.8	Y	7/23-27	15529	5.6	12.0	0	0	- -	- -	- -	
	Rovada	4	2007	108	135	4.5	Y	7/23-27	21898	7.2	10.7	0.5	0	- -	- -	- -	
White Currants - *Ribes rubrum*																	
	Blanka	4	2007	109	141	4.8	Y	7/27-30	22253	5.4	11.6	0	0	- -	- -	- -	Heavy crop
	Swedish White	4	2007	103	134	5.0	Y	7-20	23188	5.0	11.3	0	0	- -	- -	- -	Heavy crop

Type of Plant	Cultivar Name	Number of plants	Year Planted	Ave Height	Ave Canopy Width	Vigor	Fruit Set	Harvest Date	Weight of Fruit	Ave. Wt of 10 berries	Brix	Rust	Powdery Mildew	Aphids	Disease	Insect Damage	Note
				cm	cm	0-5	yes/- -		gm	gm	% solids = % sugars	0-3	0-3	0-3	0-3	0-3	
Gooseberries - *Ribes uva-crispa*																	
	Captivator*	1	2008	102	190	5.0	- -	- -	- -	- -	- -	- -	0	- -	0.5	- -	*Inner area of all plants*
	Black Velvet*	1	2010	106	200	5.0	- -	- -	- -	- -	- -	- -	0.5	- -	0.5	- -	*have missing leaves*
	Hinnomaki Red*	1	2010	68	112	3.0	- -	- -	- -	- -	- -	- -	0	- -	0.5	- -	*and spots due*
	Jahn's Prairie*	1	2008	106	154	3.0	- -	- -	- -	- -	- -	- -	0	- -	1.0	- -	*to disease.*
	Jewel*	1	2010	76	145	3.0	- -	- -	- -	- -	- -	- -	0	- -	1.0	- -	
	Lepaa Red*	1	2010	73	150	5.0	- -	- -	- -	- -	- -	- -	0	- -	0.0	- -	No disease here.
	Red George*	1	2010	78	170	4.0	- -	- -	- -	- -	- -	- -	0	- -	2.0	- -	
	Red Jacket*	1	2010	50	148	3.0	- -	- -	- -	- -	- -	- -	0	- -	2.0	- -	
	* = Reduced plant number to 1 and moved Oct. 2010.																
Edible Blue Honeysuckle [Russian Honeyberry] *Lonicera caerulea ssp edulis or kamtshatica*																	
	Berry Blue	4	2007	137	160	5.0	Y	6-27	4589	6.8	15.5	- -	0	- -	- -	- -	*Recorded dark leaves*
	Blue Belle	4	2007	85	101	4.0	Y	6-15	1711	7.0	15.6	- -	0	- -	- -	- -	*as P.M. May only be*
	Blue Moon	4	2007	88	140	4.8	Y	7-3	5275	10.5	12.2	- -	0	- -	- -	- -	*sunburn on old leaves.*
	Blue Velvet	4	2007	78	165	5.0	Y	7-16	1797	13.6	12.8	- -	0	- -	- -	- -	
	Kamchatka	4	2007	101	108	4.3	Y	6-21	1421	6.4	14.2	- -	0	- -	- -	- -	
Edible Blue Honeysuckle [Oregon Haskap] *Lonicera caerulea ssp emphylocalyx.*																	
	22-37	3	2008	- -	- -	- -	Y	7-10	3346	- -	- -	- -	0	- -	- -	- -	Study completed
	41-100	3	2008	- -	- -	- -	Y	7-10	6039	- -	- -	- -	0	- -	- -	- -	Study completed
	43-87	3	2008	99	122	4.3	Y	7-3	5429	17.5	15.7	- -	0	- -	- -	- -	Most sweet and tasty.
	43-97	3	2008	96	122	4.7	Y	7-3	2459	16.8	15.4	- -	0	- -	- -	- -	
	45-57	3	2008	116	122	4.7	Y	7-9	2836	19.4	12.0	- -	0	- -	- -	- -	Next best.
	85-26	3	2008	- -	- -	- -	Y	7-10	6071	- -	- -	- -	0	- -	- -	- -	Study completed
Edible Blue Honeysuckle [Canadian Haskap] *Lonicera caerulea*																	
	9-15	5	2008	74	119	5.0	Y	6-26	3475	9.6	15.6	- -	0	- -	- -	- -	*Crop is still very*
	9-91	5	2008	74	114	5.0	Y	6-26	936	8.7	14.6	- -	0	- -	- -	- -	*small. Pollinizer planted*
	Tundra (9-84)	5	2008	61	103	3.6	Y	6-26	2341	10.2	14.2	- -	0	- -	- -	- -	*within demo June 2012.*
	Borealis (9-94)	5	2008	69	107	5.0	Y	6-26	1231	10.4	14.3	- -	0	- -	- -	- -	
	MT 46-55	1	2009	50	74	2.0	Y	6-26	106	10.1	16.0	- -	0	- -	- -	- -	
Juneberry - *Amelanchier alnifolia*																	
	Honeywood	20	2006	136	- -	3.5	Y	7/3-10	32868	11.5	- -	- -	- -	- -	2.7	- -	*Entomosporium leaf*
	JB30	20	2006	149	- -	4.0	Y	7/3-10	30454	14.5	- -	- -	- -	- -	1.1	- -	*and berry spot on all*
	Martin	20	2006	153	- -	4.0	Y	7/3-10	25203	15.7	- -	- -	- -	- -	1.1	- -	*leaves due to weather.*
	Smoky	20	2006	151	- -	4.0	Y	7/3-10	33553	8.6	- -	- -	- -	- -	1.9	1	Thrips in flowers
	Thiessen	20	2006	153	- -	4.0	Y	7/3-10	32202	15.6	- -	- -	- -	- -	1.4	- -	
					Trunk												
Plums - Native x *P. salicina*					Caliper mm												
	Prairie Red Hyb.	2	2010	- -	14	3.5	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	
	Pembina	4	2006	- -	82	4.5	Y	8/7-11	- -	- -	- -	- -	- -	- -	- -	- -	Very big crop on 2 trees.
	Pipestone	5	2006	- -	66	3.4	Y	8-11	- -	- -	- -	- -	- -	- -	- -	- -	A few plums.
	Toka	5	2006	- -	89	4.8	Y	8-24	- -	- -	- -	- -	- -	- -	- -	- -	Big crop on 1 tree.
	Waneta	5	2006	- -	70	3.8	Y	8-11	- -	- -	- -	- -	- -	- -	- -	- -	A few plums.

Northern Hardy Fruit Project Production Records

		No. of	2009		2010		2011		2012	
		plants	Date	pounds	Date	pounds	Date	pounds	Date	pounds
Aronia	Nero	4	15-Sep	28.5	9-Sep	37.3	9/19-23	28.1	8/22-24	28.6
	Raintree Seedling	4	16-Sep	26.9	10-Sep	40.3	23-Sep	20.4	8/22-24	29.0
	Raintree Select	4	15-Sep	16.9	8-Sep	29.8	19-Sep	22.3	8/22-24	41.2
	Viking	4	16-Sep	33.8	10-Sep	40.6	19-Sep	20.3	8/22-24	39.6
				106.1		**148.0**		**91.1**		**138.4**
Hardy Cherries	SK Carmine Jewel	12	28-Jul	x	28-Jul	37.4	8/2-4	34.1	7/10-11	137.6
	SK Crimson Passio	12	28-Jul	x	28-Jul	7.7	4-Aug	2.7	7/10-12	94.7
						45.1		**36.7**		**232.2**
	Evans / Bali	3	22-Jul	x	22-Jul	**0.7**	6-Aug	**7.2**	x	**x**
Black Currant	*Whistler*	12	10-Aug	66.2		x		x		x
Variety Trial	*Black Down*	16	27-Jul	43.2	29-Jul	29.5	15-Aug	49.4	24-Jul	18.7
	Hilltop Baldwin	16	30-Jul	20.2	29-Jul	11.3	18-Aug	42.4	24-Jul	2.9
	Titania	16	30-Jul	65.9	2-Aug	10.4	8/23-25	45.7	24-Jul	58.7
	Swedish Black	16	27-Jul	21.8	2-Aug	2.7	8/16-22	25.2	24-Jul	0.5
				217.2		**78.5**		**162.7**		**80.7**
Black Currant	Ben Lomand	4	10-Aug	0.9	2-Aug	4.9	16-Aug	5.9	7/23-25	13.0
	Champion	4	29-Jul	5.2	2-Aug	4.2	16-Aug	8.6	23-Jul	3.6
	Blackcomb	4	4-Aug	16.6		x		x	x	x
	Minaj Smyriou	4	23-Jul	0.5	29-Jul	4.4	16-Aug	8.7	24-Jul	18.3
				23.2		**18.6**		**23.2**		**35.0**
Red Currant	Jhonkheer Van Tet	4	x	x	11-Aug	4.7	25-Aug	17.7	16-Jul	35.3
	Red Lake	4	31-Jul	18.4	29-Jul	21.3	9-Aug	30.3	7/23-27	23.8
	Redstart	4	10-Aug	9.8	9-Aug	12.3	8-Aug	24.7	30-Jul	20.1
	Rosetta	4	19-Aug	6.4	11-Aug	8.4	17-Aug	40.4	7/23-27	34.2
	Rovada	4	11-Aug	6.0	10-Aug	10.1	17-Aug	33.3	7/23-27	48.2
				40.6		**56.8**		**146.4**		**161.7**
White Currant	Blanka	4	14-Aug	9.1	10-Aug	18.9	26-Aug	23.5	7/27-30	49.0
	Swedish White	4	4-Aug	5.5	3-Aug	14.6	4-Aug	29	20-Jul	51.1
				14.6		**48.1**		**52.5**		**100.1**
Ore. Honeyberry	22-37	3	20-Jul	0.3	6-Jul	2.3	28-Jul	2.4	10-Jul	7.4
	41-100	3	20-Jul	0.5	6-Jul	3.8	28-Jul	2.8	10-Jul	13.3
	43-87	3	20-Jul	0.1	6-Jul	1.1	21-Jul	4.4	3-Jul	12.0
	43-97	3	20-Jul	0.3	6-Jul	3.4	1-Aug	3.2	3-Jul	5.4
	45-57	3	20-Jul	0.6	6-Jul	3.3	27-Jul	4.4	9-Jul	6.2
	85-26	3	20-Jul	0.5	6-Jul	3.9	27-Jul	6.2	10-Jul	13.4
				2.3		**17.8**		**23.4**		**57.7**
Rus. Honeyberry	Berry Blue	4	x	x	2-Jul	9.3	12-Jul	12.6	27-Jun	10.1
	Blue Belle	4	x	x	15-Jun	5.6	7-Jul	6.2	15-Jun	3.8
	Blue Moon	4	20-Jul	2.0	7-Jul	3.5	x	x	3-Jul	11.6
	Blue Velvet	4	20-Jul	3.0	2-Jul	2.7	x	x	16-Jul	4.0
	Kamchatka	4	x	x	2-Jul	2.0	7-Jul	6.4	21-Jun	3.1
				5.0		**23.2**		**25.2**		**32.6**
Haskaps	Borealis	4	x	x	x	x	20-Jul	0.5	26-Jun	2.7
- Canadian	Tundra	5	x	x	x	x	14-Jul	4	26-Jun	5.2
	Indigo Gem (9-15)	5	x	x	x	x	12-Jul	4.8	26-Jun	7.7
	Indigo Treat (9-91)	5	x	x	x	x	14-Jul	1.4	26-Jun	2.1
								10.7		**17.6**
Juneberry	*JB30*	20	17-Jul	3.6	7-Jul	37.5	15-Jul	51.7	2-Jul	72.4
Variety Trial	*Honeywood* ++	20	to	20.5	to	37.3	to	43.7	to	67.1
	Martin	20	24-Jul	1.6	16-Jul	13.8	25-Jul	28.1	10-Jul	55.5
	Smoky	20		9.4		43.2		29.1		73.9
	Thiessen	20		9.7		29.3		48.1		70.9
				44.9		**161.2**		**200.7**		**339.8**

++ - Juneberries are picked 3 times. Smoky produces longer than this.

The Project was planted in 2007, except Juneberries 2006.

Recommendations from the Carrington REC Fruit Project

NDSU Carrington Research Extension Center has been evaluating northern-hardy fruit varieties since 2006. The following varieties are hardy, have done the best or have the most useful fruits. For a full list of cultivars, contact the fruit project manager.

Apples: CREC has five varieties of apples easily grown in central North Dakota: *'Haralred', 'Hazen', 'Sweet Sixteen'*, *'Honey Crisp'* and *'Zestar'*. Our selection of 'Haralred' does not mature well and 'Sweet Sixteen' takes a very long time to fruit – though it is delicious.

Varieties: *(recommended with reservations) 'Hazen', 'Honey Crisp', 'Zestar'* and *'Sweet Sixteen'*.

Plums: Plums have been spottily productive at CREC. Try a wild plum as a pollenizer.

Varieties: *(recommended with reservations) 'Pembina', 'Pipestone', 'Toka'* and *'Waneta'*.

Grapes: Eighteen varieties are being evaluated for winter hardiness, ability to ripen and other qualities. The easiest-to-grow, most hardy grape for North Dakota is *'Valiant'. 'Somerset Seedless' has done well.*

Aronia: (*Aronia melanocarpa*) Or, Black Chokeberry, is a native North American plant developed into a commercial fruit in Eastern Europe. The fruit requires processing as it is quite astringent right off of the bush but is very nutritious and high in anthocyanins. High interest in Central Plains.

Varieties: *'Viking', 'Nero', 'Raintree Select', possibly 'McKenzie'.*

Cherries: (*Prunus x kerrasis*) These dwarf, zone 2-hardy pie cherries grow on a 5'x 7' high bush that can produce 20 to 30 lbs of fruit per plant. They are just becoming readily available in the US. Fruit is dark red throughout and has high sugar content.

Varieties: *'Carmine Jewel', 'Crimson Passion' (harder to find).* ***Tree:*** *'Evans' aka 'Bali'.*

Currants: (*Ribes nigrum* and *rubrum*) Black currants have 5 times the amount of vitamin C in oranges and are loaded with antioxidants and anthocyanins. They are super-popular in Europe as juice, syrups and spreads. Jam, juice, wine and cordials are delicious. Flowers are susceptible to late-season freezes. Powdery mildew may be a problem. Near white pine trees, plant rust-resistant cultivars.

Varieties: Black: *'Titania', 'Blackdown', 'Ben Lomand', 'Champion'.*

Red: *'Red Lake', or any.* ***White:*** *'Swedish White'.*

Honeyberry aka Haskap: (*Lonicera caerulea* var. *edulis*) A very hardy and unique small shrub with tasty, early-ripening fruit similar to blueberries. No special soil conditions are needed. A circumpolar native, CREC has 6 Russian, 18 Japanese and 4 Canadian cultivars.

Varieties: Haskap: *'Indigo Gem', 'Tundra', 'Borealis'.* ***Pollenizers:*** *'Berry Blue', 'Blue Belle', 'Aurora'.*

Juneberry: (*Amelanchier alnifolia*) Juneberries are native to the northern Great Plains; the fruits are delicious fresh, frozen or processed. Bird damage can be a problem and there is native disease pressure.

Varieties: *'Martin', 'Thiessen', 'JB30', 'Honeywood'. Good u-pick potential.*

Gooseberries: (*Ribes uva-crispa L.*) Many varieties are susceptible to leaf diseases. Plants have thorns but the fruit is tasty and sweet-tart. Use like fresh grapes or make pies and jam.

Varieties: *'Hinnomaki Red', 'Captivator', 'Jewel', 'Red George', 'Black Velvet', 'Lepaa Red'.*

Sea Buckthorn or Sea Berry: (*Hippophae rhamnoides*) Not recommended – Potentially invasive.

Elderberries: (*Sambucus canadensis*) Commercial varieties don't ripen at CREC and are not winter hardy. We are searching for hardier selections that we have heard about.

Contact: Kathy Wiederholt, Fruit Project Manager. Kathy.Wiederholt@ndsu.edu; 701-652-2951

CREC Fruit Project Survey

The CREC Fruit Project survey was created on the free version at SurveyMonkey.com. We are not able to print out a copy of the survey, but I used page images to create the representation of the results below.

Following the primary 10-question survey is a list of additional answers which were optional and are descriptive.

Response Summary

Total Started Survey: 69
Total Finished Survey: 69 (100%)

PAGE: 1

1. How did you hear about the Fruit Project?

Create Chart Download

	ResponsePercent	ResponseCount
Newspaper press release for an event	5.8%	4
Newspaper or magazine article about the overall project	5.8%	4
CREC Website	2.9%	2
CREC Fruit Project Facebook page	0.0%	0
ND Grape Growers listserve	36.2%	25
Extension program	50.7%	35
	Other (please specify) Show Responses	10
	AnsweredQuestion	69

2. Have you attended a tour of the CREC Fruit Project or a presentation at another location?

Create Chart Download

	ResponsePercent	ResponseCount
I have attended an orchard tour	33.3%	23
I was at a presentation in another place	10.1%	7
I've done both	18.8%	13
No, I have not	40.6%	28
	AnsweredQuestion	69

3. Did the information you received encourage you to plant fruits? Create Chart Download

	ResponsePercent	ResponseCount
Yes	75.4%	52
No	4.3%	3
I haven't been to a presentation yet	20.3%	14
	AnsweredQuestion	69

4. How many fruit plants did you have 5 years ago? Create Chart Download

	ResponsePercent	ResponseCount
zero	31.9%	22
1 to 5	21.7%	15
6 to 10	21.7%	15
11 to 25	7.2%	5
26 to 100	13.0%	9
More than 100 plants? What were the main plants in your orchard or vineyard? Show Responses	7.2%	5
	AnsweredQuestion	69

5. How many fruit plants do you have today? Create Chart Download

	ResponsePercent	ResponseCount
zero	2.9%	2
1 to 5	8.7%	6
6 to 10	14.5%	10
11 to 25	21.7%	15
26 to 100	23.2%	16
101 to 200	8.7%	6
More than 200 plants? What are the main plants in your orchard or vineyard? Show Responses	21.7%	15
	AnsweredQuestion	69

6. Do you plan to add more fruit plants in the future? Create Chart Download

	ResponsePercent	ResponseCount
Yes	82.4%	56
No	17.6%	12
If yes, you may describe your plans. (ex: I plan to add 12 gumdrop trees next year) Show Responses		34
	AnsweredQuestion	68

7. Do you sell your fruit or have plans to sell your fruit? Create Chart Download

	ResponsePercent	ResponseCount
I don't or won't sell my fruit - I use it myself or give it away	68.7%	46
I plan to sell all of my fruit	6.0%	4
I use some myself and sell the rest	25.4%	17
To whom might you sell your fruit? (ex: U-pick customers, a winery, farm market customers, etc) Show Responses		18
	AnsweredQuestion	67

8. Do you or will you process your own fruit into... Create Chart Download

	ResponsePercent	ResponseCount
I won't process my own fruit	2.9%	2
Jellies and jams	**73.5%**	**50**
Juice	52.9%	36
Pies	55.9%	38
Wines or similar beverages	44.1%	30
It's for fresh or frozen eating	67.6%	46
I use it in my business	5.9%	4
Please describe fruit use in your business Show Responses		9
	AnsweredQuestion	**68**

9. How do you catagorize your fruit growing? Create Chart Download

	ResponsePercent	ResponseCount
Home Gardener	**68.1%**	**47**
Fruit Hobbyist	27.5%	19
U-pick or Farmers Market sales (retail)	14.5%	10
Grow for others (wholesale)	7.2%	5
Grow to use in my own business	13.0%	9
I grow for wildlife	15.9%	11
	AnsweredQuestion	**69**

10. Final Question! What fruits do you grow? Create Chart Download

	ResponsePercent	ResponseCount
Apples	80.9%	55
Apricots	26.5%	18
Aronia	17.6%	12
Cherries	61.8%	42
Chokecherries	50.0%	34
Red Currants	25.0%	17
Black Currants	32.4%	22
Elderberries	20.6%	14
Gooseberries	23.5%	16
Grapes - Table/Juice/Jelly	52.9%	36
Grapes - Wine	38.2%	26
Honeyberries/Haskaps	61.8%	42
Juneberries/Saskatoons	42.6%	29
Pears	23.5%	16
Plums	42.6%	29
Raspberries	69.1%	47
Strawberries	54.4%	37
Nuts (ex. hazelnut)	13.2%	9
Other (please specify) Show Responses	22.1%	15
	AnsweredQuestion	68

Additional worded responses to Survey Questions:

4.	How many fruit plants did you have 5 years ago? *More than 100 plants? What were the main plants in your orchard or vineyard?*
	Showing 5 text responses — No responses selected Grapes, Apples, Pears, Cherries 12/16/2012 8:59 PM View Responses Crab Apples(200), June Berry (500), Grapes (20) 12/14/2012 2:09 PM View Responses grapes, Canadian Cherries, haskaps, currants 12/14/2012 12:13 AM View Responses apples juneberries 3kinds currants cherries raspberries grapes haskaps pears carmine cheries 12/11/2012 8:38 PM View Responses 800 grapevines, 30 currants 12/11/2012 7:10 PM View Responses
5.	How many fruit plants do you have today? *More than 200 plants? What are the main plants in your orchard or vineyard?*
	Showing 16 text responses — No responses selected Junebernes, haskap, sour cherry 1/9/2013 12:24 AM View Responses haskaps apples apricots plums raspberries cherries and grapes 1/2/2013 8:47 PM View Responses Aronia Berry, Sandcherry, Nanking Cherry, Juneberry, Haskap, Carmin Jewel, Plum, Apple, Pear, Currant, Cranberry, Chokecherry . . . . 1/2/2013 11:12 AM View Responses Grapevines and plum trees 1/2/2013 11:03 AM View Responses juneberrys 12/27/2012 8:57 PM View Responses Grapes, Juneberries,Raspberries 12/18/2012 1:22 PM View Responses Grapes, Apples, Pears, Cherries, Apricots, Gooseberries, Raspberries, Black Currants, Haskaps. 12/16/2012 8:59 PM View Responses Naking Cherries (80), Crab Apples(200), Choke Berry (50), Haskap, Jewel Cherry (50), Grapes (70), June Berries (200) 12/14/2012 2:09 PM View Responses grapes, Canadian Cherries, haskaps, currants, raspberries, Juneberries 12/14/2012 12:13 AM View Responses aronia, haskap, red currant, black currant, elderberry, gooseberry, peach, pear, chokecherry 12/12/2012 9:14 AM View Responses same as previous 5 years 12/11/2012 8:38 PM View Responses 1350 grapevines, 250 Canadian cherries, 100 haskaps, 30 currants, 300 raspberries 12/11/2012 7:10 PM View Responses ARONIA - VIKING 12/11/2012 4:19 PM View Responses over 1200 grapes, over 100 cherries, over 200 haskaps, over 50 juneberries, over 50 appricots, over 50 currents, over 50 plums 12/11/2012 4:04 PM View Responses small fruits - currants, nanking cherries, carmine jewel cherries, aronia, chokecherry, raspberry, etc 12/11/2012 3:04 PM View Responses
6.	Do you plan to add more fruit plants in the future? *If yes, you may describe your plans. (ex: I plan to add 12 gumdrop trees next year)*

	Showing 34 text responses No responses selecte Additional apple tree, plum trees, grapevines. Perhaps some seaberry, gooseberry, or hardy kiwi. 1/14/2013 10:35 AM View Responses I'd like to add two elderberry, and replace overgrown lilacs with seaberry; and add a few aronia to the front yard. The gooseberries have been amazing and I want to add more. 1/14/2013 8:47 AM View Responses More Juneberries, more haskaps 1/9/2013 12:24 AM View Responses we'd like to add 3 apple & 3 apricot & maybe 2 pear for a small home scale orchard 1/3/2013 12:13 AM View Responses we plan on more raspberries and currants this year 1/2/2013 8:47 PM View Responses Have not yet decided on a specific plan. 1/2/2013 4:12 PM View Responses
6.	Do you plan to add more fruit plants in the future? **(cont'd)** *If yes, you may describe your plans. (ex: I plan to add 12 gumdrop trees next year)*

adding 100+ grapevines this spring.
1/2/2013 11:03 AM View Responses

I plan to add more apple and elder berry trees.
12/29/2012 2:37 PM View Responses

yes I plan to plant about 10 apple and small fruit in a shelter belt area around my property. small fruit like sand cherry,current,gooseand elder and more grapes on the garden area
12/29/2012 9:18 AM View Responses

I want to add more Juneberries, hazelnuts and mulberries to my collection.
12/16/2012 8:59 PM View Responses

A variety of fruit plants that grow in our climate is what I want to try.
12/14/2012 4:11 PM View Responses

150 Nanking Cherry, 150 choke berry
12/14/2012 2:08 PM View Responses

not sure, we'll see how these do and go from there.
12/14/2012 9:30 AM View Responses

I plan to add 50 raspberries, 100 grapes
12/14/2012 12:13 AM View Responses

Next year I will plant 325 grape vines.
12/12/2012 11:36 AM View Responses

I would like to add haskaps, but need to make room.
12/12/2012 11:34 AM View Responses

highbush cranberry, plum
12/12/2012 9:14 AM View Responses

MY futre son-in-law wants to plant some
12/12/2012 8:18 AM View Responses

Plan to add more Apples, Raspberries, and Strawberries
12/11/2012 11:03 PM View Responses

A current and a honeyberry. Replace a raspberry.
12/11/2012 9:18 PM View Responses

other new varietes
12/11/2012 8:38 PM View Responses

We plan to increase the number of haskaps by 25 and cherries by 50. Apple (17) and black currents (5) will be doubled
12/11/2012 8:17 PM View Responses

30 more currants, 30 more grapes. Two years from now, 200 more haskaps.
12/11/2012 7:10 PM View Responses

We were thinking of grapes, but after the tour are thinking seriously of aronia and haskaps
12/11/2012 5:49 PM View Responses

I recently planted two apple trees, and plan to improve my raspberry and strawberry production.
12/11/2012 4:21 PM View Responses

I am going to plant some black ice plum and few apple trees next year
12/11/2012 4:19 PM View Responses

Up to 2000 more grapes of new varieties, several dozen apple and pear, 500 to 100 raspberries, more currents, plums and apricots, several hundred aronia
12/11/2012 4:04 PM View Responses

I am going to plant 3 plum trees, toka and black ice I am also adding three new apple variety
12/11/2012 3:58 PM View Responses

I plan to put some in out at the farm where my brother lives. I live in town.
12/11/2012 3:51 PM View Responses

Hope to be a commercial grower in the next 5-10 years
12/11/2012 3:47 PM View Responses

would like to add more apple trees and raspberries, also maybe more honeyberries or new varieties as they become available - more aronia too.
12/11/2012 3:04 PM View Responses

7.	Do you sell your fruit or have plans to sell your fruit? *To whom might you sell your fruit? (ex: U-pick customers, a winery, farm market customers, etc.)*
	Showing 18 text responses — No responses selected Farmers market 1/8/2013 12:24 AM View Responses till the winery is open will sell excess fruit at farmers market and possible wineries 1/2/2013 8:47 PM View Responses Depending on yield I am thinking to process some of it and possibly sell the product. 1/2/2013 4:12 PM View Responses Any outlet that wants some. We have sold to a winery and a foods place. 1/2/2013 11:12 AM View Responses I would just put up a sign on the highway and they pick their own. 12/29/2012 9:18 AM View Responses U-pick 12/27/2012 8:57 PM View Responses Winery, donate to school 12/16/2012 8:59 PM View Responses Winery 12/14/2012 2:09 PM View Responses wineries, U pick customers, farm market customers 12/14/2012 12:13 AM View Responses upick 12/12/2012 9:14 AM View Responses Farm Market customers and u-pick Sneaky pheasants, partridge, and deer. 12/11/2012 11:03 PM View Responses Farmers market customers, anyone interested in the fruit 12/11/2012 8:17 PM View Responses wineries, farmer's market 12/11/2012 5:49 PM View Responses I would consider selling, but wish there were Farmer Market opportunities closer to my home. Not worth the gas money to drive all the way to Devils Lake (43 miles one way). 12/11/2012 4:21 PM View Responses wineries, jam/jelly producers, local customers 12/11/2012 4:19 PM View Responses As my plants mature, I will use some in wine and juice production, some will be sold u-pick, others may be sold in bulk to local wineries or grocery stores. fresh eating sales 12/11/2012 3:58 PM View Responses U-pick and farmers market - extra that might come all in one picking to wineries if timing and price works out. 12/11/2012 3:04 PM View Responses
8.	Do you or will you process your own fruit into… *Please describe fruit use in your business*

Showing 9 text responses — No responses selected

i would love to market in a business format but at this stage we are using for our own use but would love to see some type of greenhpouse growing using the natural gas being burned off in the oil well areas be used to heat a green house to grow several types of fruit and veg.
12/29/2012 9:18 AM View Responses

pending
12/14/2012 2:09 PM View Responses

my plants have not produced anything yet, however the plans I have for the fruit....are the answers to # 8
12/13/2012 10:38 PM View Responses

Weare a winery, but do also sell excess fruits to interested parties
12/12/2012 9:14 AM View Responses

We make many different fruit wines.
12/11/2012 7:10 PM View Responses

currently we just grow for our own use but are looking into growing for wholesale
12/11/2012 5:49 PM View Responses

the majority of berries will be sold. a small amount will be retained for personal/family making of jelly and juice (currently not for sale)
12/11/2012 4:19 PM View Responses

Strawberrys
12/11/2012 3:58 PM View Responses

will eventually sell at farmers markets
12/11/2012 3:04 PM View Responses

10. What Fruits do you grow?

Other (please specify)

Showing 15 text responses — No responses selected

Cape gooseberry (annual)
1/14/2013 8:47 AM View Responses

Many (75+) are conservation seedlings: hazelnut, aronia, nannyberry
1/3/2013 12:13 AM View Responses

big blue plumb, nectarine,peach,pear,sweet cherry,
1/2/2013 12:32 AM View Responses

some not yet producing
1/2/2013 12:27 AM View Responses

Smooth Sumac, Cranberries
1/2/2013 11:12 AM View Responses

Juneberrys
12/27/2012 8:57 PM View Responses

Mulberries,
12/16/2012 8:59 PM View Responses

Blackberries
12/12/2012 1:42 PM View Responses

Does rhubarb count?
12/12/2012 11:36 AM View Responses

peaches, kiwi, cranberries
12/12/2012 9:14 AM View Responses

Josta Berry Black Raspberry Vine Black Cherry
12/11/2012 9:18 PM View Responses

buffaloberries sand cherries Canada bush cherries
12/11/2012 7:10 PM View Responses

Am always interested in trying anything new-as long as a gardening friend or expert recommends it for our area.
12/11/2012 4:21 PM View Responses

sand cherries
12/11/2012 4:04 PM View Responses

highbush cranberry, rhubarb,
12/11/2012 3:04 PM View Responses

Images from the Northern Hardy Fruit Project, 2011-2012

Planting new Haskap varieties

Field Day 2012: Speaker and Tasters! (80 attendees)

Juneberries

Flowers and young currants

Beautiful 'Pembina' Plums

Testing berry juice for pH and titratable acidity

PROJECT 8: SLOW DARKENING PINTO BEANS: DEVELOPMENT, AGRONOMIC PERFORMANCE, AND QUALITY TESTING

Final Report

Project Summary

Dry edible beans are the most important legume for direct consumption worldwide. It is an excellent source of protein, fiber, micronutrients, and folate, among other components. Seed visual quality is an important factor for consumers and consequently, growers and processors always make big efforts to ensure production and delivery of dry beans with high quality. However, dry beans (especially pinto beans) are prone to seed discoloration or darkening when stored by long periods of time at undesirable conditions or when harvest is delayed due to environmental factors such as rain. Darkened beans have a discounted price and create big marketing issues. A slow darkening gene (*sd*) has been discovered recently. Breeding populations of pinto beans that are segregating for the *sd* gene are being developed collaboratively between the NDSU dry bean breeding program and USDA-ARS. This project is an attempt to test this breeding material under real field conditions in North Dakota in order to evaluate their agronomic performance and adaptation, their positive or negative associations with other important traits such as cooking quality, and the identification of lines that would offer a good combination of high seed yield, good agronomic performance in North Dakota environments, and the slow darkening trait. Three main activities were successfully accomplished during the funding period: i) field testing (agronomic performance) of both advanced and Recombinant Inbred Lines (RILs) across several locations in two states (North Dakota and Washington), ii) canning evaluation of the advanced lines, and iii) evaluation of cooking times for the Recombinant Inbred Lines.

Project Approach

Field Testing of Slow Darkening Lines:

Advanced Breeding Lines:

In 2011, the first preliminary field trial with 16 advanced breeding lines with the slow darkening trait plus two checks was performed in North Dakota. The germplasm line SDIP-1 was used as the slow darkening check while Buster pinto bean was used as the susceptible check. Two locations were planted (Hatton and Prosper), but unfortunately, trials at Prosper were lost due to flooding during spring. Therefore, only data from Hatton is reported. Field trial at Hatton also suffered from excessive rain but soils in this region have better drainage and only few plots were significantly affected. The trial was planted as a randomized complete block design with 4 replications in which replications 1 and 3 were harvested at normal dates and replications 2 and 4 were harvested two weeks later in order to simulate the effect of harsh environmental conditions that regularly produce the seed darkening in the field. In addition, other agronomic variables such as plant height and 100-seed weight were also measured for each plot in order to have additional information regarding agronomic performance.

Several of these breeding lines were selected for a second trial during the 2012 growing season. In addition, newer breeding lines were added in 2012 as well as more commercial checks. A total of 19 advanced pinto lines containing the slow darkening gene (*sd*) were tested in replicated field trials across three locations in North Dakota (Hatton, Johnstown, and Prosper)

and two locations in Washington (Othello and Prosser). This trial, known as the Slow Darkening Advanced Yield Trial (SDAYT), included: i) a subset of seven lines selected based on their good agronomic performance and seed quality in the field trials made the previous growing season (2011); ii) a group of 12 new slow darkening lines coming from the USDA-ARS breeding program at Prosser-WA; iii) Four cultivars commonly grown in the region plus the source of the *sd* gene to be used as checks.

Field trials were planted as a randomized complete block design with 4 replications in which replications 1 and 3 were harvested at normal dates and replications 2 and 4 were harvested two weeks later in order to simulate the effect of harsh environmental conditions that regularly produce the seed darkening in the field. In addition, other agronomic variables such as plant height, days to maturity, and 100-seed weight were also measured for each plot in order to have additional information regarding agronomic performance.

In spite of the dry conditions across the Northern Plains region during the end of June and all July of 2012, the field trials produced very good seed yields. In addition, the dry conditions contributed to lower pressure for diseases commonly found in the region, with the exception of common bacterial blight which may have reduced seed yield significantly for some genotypes that seemed more sensitive to this bacterial disease.

Poor emergence in some genotypes, likely due to *Pythium* root rot, was observed in the trials at Washington, and data suggests that the *sd* gene may have a negative effect on germinated seedling survival. This was more evident when the source of the *sd* gene was SDIP-1 and less evident for the *sd* from the Canadian source (1533-15). A similar trend could not be found in North Dakota, where fungicide seed treatments were effective in protecting seedlings from infection by root rot pathogens during germination. Further screening is recommended to ensure that seed treatment alone can negate the germination problems observed in Washington.

The ND trials in 2012 were harvested three weeks after harvest maturity to mimic delayed harvest problems commonly faced by growers. During these extra three weeks, the trials were subject to snow and rain which provided a good test for determining usefulness of the slow darkening trait for maintaining good overall seed appearance despite delayed and poor harvest conditions. Data within and across locations and years was statistically analyzed and a group of four advanced breeding lines were selected to be included in the Pinto Variety Trials (PVT) grown at four locations in North Dakota during 2013 for additional testing and selection of potential cultivars. Simultaneously, seed increases of these lines are underway at Washington State.

Field Testing of Recombinant Inbred Lines (RILs):

In 2012, the slow darkening RIL trials were planted at two locations in North Dakota (Hatton and Prosper) and one location in Washington (Othello). The goal of these trials was to gain a better understanding of the possible effects and interactions of the slow darkening gene with agronomic performance. The trial tested 64 entries, including two commercial checks (Stampede and Santa Fe), two *sd* sources (SDIP-1 and 1533-15), and 60 RILs which originated from two separate crosses using both Stampede and Santa Fe as commercial parents. Within each

cross, 15 lines possessed the *sd* gene while it was absent in the other 15 lines. These trials were planted as squared lattices (8 x 8) with three replications.

Statistical analyses within and across locations showed no differences in seed yield between the slow darkening and the regular darkening lines. Seed yield was 2,790 pounds per acre in the regular darkening and 10 pounds more for the slow darkening lines. Statistical analyses showed differences for 100-seed weight and plant height; however, these differences are not critical for practical effects and remain within commercially acceptable levels. The 100-seed weight for the slow darkening lines was 42.9 g while for the regular darkening lines was 46.3 g. For pinto beans, anything above 35 g per 100 seeds is commercially acceptable. In fact, anything above 40 g is considered even a better seed size. In the same way, plant height did not change much between the two groups (51 cm for the slow darkening lines and 55 cm for the regular darkening). The use of Stampede and Santa Fe as commercial recurrent parents offered and opportunity to improve the overall plant architecture of the plant, producing lines that combine upright architecture (highly desirable in the region for direct harvest), the slow darkening trait, and good agronomic performance.

In conclusion, the *sd* gene does not appear to have a negative effect in the agronomic performance of these lines, which was a major concern when the agronomic performance of the original sources of the *sd* gene were tested (SDIP-1 and 1533-15). The fact that the only difference between these two groups is the presence or absence of the *sd* gene (all lines share the same genetic background within each cross) gives a strong evidence of the neutral effects of the *sd* gene in the overall agronomic performance of these lines.

A group of eight lines from this trial were selected for further testing during the 2013 growing season. These elite lines constitute the second generation of slow darkening pinto lines from which another cultivar could be released in the future. However, data is available from one year only and therefore additional field testing is needed across more environments before making any final decision regarding these lines.

Canning Evaluation of the Advanced Breeding Lines:

A preliminary canning evaluation of these lines was made using seed harvested from field trials at Prosser-WA in 2011. Canning was conducted by Dr. Karen Cichy at USDA-ARS Michigan. Preliminary results showed that the *sd* gene may affect canning quality significantly. Some lines were better canners than others, and similar to commercial pinto beans; however, the color of the slow dark pintos had much lighter appearance after canning than the regular dark pintos. Additional canning tests were made at NDSU (using seed harvested at Hatton-ND in 2011) and even though the seed color of the canned product is lighter for the *sd* lines compared with the regular darkening varieties, seed integrity was not as bad as shown in the first test. However, some sd lines still showed detrimental effects in term of seed integrity. Perhaps this is related to the reduced cooking time of the sd lines and therefore, if they cook faster they would likely need less processing than the regular pinto beans. Images of the results can be found in previous quarterly reports.

The canning evaluations are usually made in two or three weeks. First, seed from each line need to be equilibrated to a standard level of seed moisture. This process may take 2 or 3 weeks depending on the moisture content of each sample. Following equilibration, each seed

sample from each plot is canned using a retort. Cans are then opened after 8 weeks for evaluation, using a visual score from 1 to 7, where 1 to 3 is unacceptable, 4 is acceptable, and 5 to 7 is good to excellent. The visual score includes observation on overall product appearance, seed integrity (damage, splitting, clumping, tore coats, etc.), brine color (as an indicative of seed color retention), and water absorption by the seeds, among others. At least three cans per plot are evaluated by a panel of at least six evaluators during the same day. These are "blind" evaluations in which the examiners do not have any information about the samples, just entry numbers.

An independent assessment of canning quality of the slow darkening pinto beans was sought from the bean canning industry. Samples of these *sd* lines were sent to two U.S. canning companies. The results were encouraging in that slow darkening pintos provided a viable canned product. In fact, one of tests showed that three of the six slow darkening lines rated better or equal to the company's in-house control regular darkening pinto bean sample (images can be found in previous quarterly reports). This company suggested that slow darkening pintos should be maintained as a separate seed class to prevent co-mingling with regular darkening pintos. Part of the seed samples were also used to make canned refried beans. Results showed that similar to the regular canned product, the color of the refried beans was lighter than the regular darkening beans. However the company said that the lighter color is actually better because it is an indicator of freshness for the consumer.

Evaluation of Cooking Times for the Advanced Lines and RILs:

Using seed samples from Hatton-ND 2011, the sd advanced lines were sent to Dr. Karen Cichy from USDA-ARS at East Lansing-MI for an evaluation of cooking time. The main objective was to see if there is direct relation between seed darkening and cooking time. For each line a sample of 30 seed were weighed and soaked for 12 hrs in DI water. After 12 hrs water was drained and seed weight measured. Next 25 of the soaked seeds were cooked with a Mattson bean cooker in boiling water. This apparatus consists of a cooking rack with 25 perforated depressions with a weighted plunger aligned above each depression. When a seed is fully cooked, the plunger pierces through it and drops through the perforation in the cooking rack. The cooking time was recorded for the time is takes for 50% and 80% of the plungers to pierce the seeds. A colorimeter, Hunter Labscan XE (Hunter Associate Laboratory, Inc., Reston, VA 20190, USA), was used for extracting color parameters from raw and cooked beans. For analysis, three measurements of color were extracted: $L^*a^*b^*$ or CIELAB color channels. Among these, the most important for this study is L^* which is an indicator of the luminance or lightness component that goes from 0 (black) to 100 (white).

Since only one regular darkening sample was included in the 2011 experiment (Buster), the conclusions were limited at that point. However, results suggest that a range of variation exists for cooking time that does not appear to be directly related with the *sd* gene. In addition, there was no statistical difference between the samples from the regular and delayed harvest, which suggests that cooking time is not directly related to harvest time. In other words, fresh beans that happened to be dark due to field conditions can cook as fast as fresh beans with normal color. In the same way, cooking tests were also made for a subset of the RILs using seed from the 2012 trials grown in North Dakota and Washington. From each of the two crosses, 10 slow darkening lines and 10 regular darkening lines were randomly chosen and sent to Dr. Cichy.

Results showed that there is a very strong effect of location, which suggest that the environmental conditions of the region where the beans are produced has more effect in cooking time than the genotype itself. There were also significant differences for cooking times between the slow darkening lines (28.4 min.) and the regular darkening lines (31.8 min.). While the average difference is only 4 min., this may be a good selling point for dry seed sales. Not only do they look better but they also cook faster. In the same way, the canning industry could reduce their cooking time for the sd beans in their protocols and hence, reducing overall time and energy through the process. There was no interaction of location by seed type (slow darkening vs. regular darkening). In addition, there was no difference for seed moisture before cooking in order to avoid confounding of this into the tests.

Goals and Outcomes Achieved

This study has allowed us to make the following observations:

1. The slow darkening gene (*sd*) is highly effective in conserving an excellent seed color even when plants are left in the field after the optimal harvest date in North Dakota. Very contrasting results can be observed when compared with commercial susceptible checks. Few breeding lines may have potential as future commercial cultivars because they offer a good agronomic package that includes high seed yield as well as seed size and maturity within the acceptable ranges. In the past, the low seed yield of the original sources of the *sd* gene has been the main limitation for the rapid adoption of these new materials by the growers.
2. Both seed yield and seed size (expressed as 100-seed weight) of several breeding lines are competitive with commercial checks commonly grown in the region. Therefore, these breeding lines offer a good combination of competitive yield potential with the slow darkening trait, especially when compared with the original source of the *sd* gene (SDIP-1), which had one of the lowest seed yield.
3. The slow darkening gene (*sd*) is highly effective in conserving an excellent seed color even when plants are left in the field after the optimal harvest date in North Dakota.
4. The slow darkening pinto lines have variation for canning quality that seems to be directly related to the *sd* gene. The final canned product of the slow darkening lines has a lighter color than the regular pinto cultivars. However, the industry feedback suggests slow dark pintos would be considered acceptable under commercial conditions.
5. The lighter color is not an issue for the dry commodity market. In fact, it is a highly desirable trait because it is regarded by the consumer as an indicator of freshness (recently-harvested beans) and faster cooking, also a trait that consumers associate with freshness.
6. The presence of the *sd* gene slightly reduces the cooking time by 4 min. However, the location where the dry beans are grown (environmental conditions) seems to be the main factor affecting cooking time. Additional testing across more locations and years is needed in order to validate this conclusion
7. A final group of 12 lines (8 RILs and 4 advanced lines) are currently in the final stages of testing in order to make final decisions for commercial release.

Beneficiaries

The dry bean growers of North Dakota will be the main beneficiaries once the best slow darkening line or lines are commercially released. There are approximately 1,500 dry bean

growers in North Dakota, all of which have the opportunity to benefit from this project. This will avoid discounted prices for the growers, a high quality product that will be more appealing to the consumers and will increase the good reputation of the North Dakota dry bean industry both at the national and global level. In addition, other breeding programs will have access to this germplasm so it can be used in new crosses. Similar efforts could be done for other market classes having the same darkening issues such as cranberry and pink, among others.

Lessons Learned

1. The presence or absence of the *sd* gene does not have any effect on the agronomic performance of the lines evaluated in this study. However, there is an effect in the color of the final canned product, producing a seed color that is lighter than usual. Nonetheless, industry feedback supports the development of these specialty cultivars and recommends some ways to avoid mixtures of slow darkening with regular darkening beans within the same can.
2. The lighter color is not an issue for the dry commodity market. In fact, it is a highly desirable trait because it is regarded by the consumer as an indicator of freshness (recently-harvested beans).
3. The presence or absence of the *sd* gene does appear to have an small reduction in the cooking time. Environmental conditions (location) seem to be the major factor affecting cooking time.
4. It was possible to eliminate the negative effects related to agronomic performance (linkage drag) observed in the original sources of the *sd* gene (SDIP-1 and 1533-15).

Contact

Principal Investigator: Juan M. Osorno Ph.D.
Dry Bean Breeding & Genetics, Department of Plant Sciences North Dakota State University, 1360 Albrecht Blvd. - Loftsgard Hall 374-E NDSU Dept. 7670 - P.O. Box 6050 Fargo, ND 58108-6050 Ph: 701-231-8145 / FAX: 701-231-8474. Juan.Osorno@ndsu.edu

Co-Investigator: Phillip Miklas Ph.D.
USDA-ARS 24106 North Bunn Road Prosser, WA 99350 Phone: 509-786-8492; Fax: 509-786-9277 phil.miklas@ars.usda.gov

Additional Information

Project updates and results have been shared with growers at the Bean Day in January each year, the Northarvest Beangrower Magazine (http://www.northarvestbean.org/html/info.cfm?ID=7) and field days during the growing season, among others. The project was presented at Bean Day during the last 3 years (2011, 2012, and 2013), and organized by Northarvest bean growers association. There is an average of 400 growers attending this annual meeting. In addition, the project has been mentioned at several field days at the NDSU Research and Extensions Centers. The field days have a minimum attendance of at least 150 growers at different locations in the state. Northarvest Beangrower magazine has published updates about the project at least twice. In addition, a scientific article is under development in order to share the information with the rest of the scientific community.

PROJECT 9: DEVELOPMENT OF NITROGEN MANAGEMENT PRACTICES IN MINNESOTA AND NORTH DAKOTA TO REDUCE ACRYLAMIDE LEVELS IN PROCESSED POTATO PRODUCTS

Final Report

Project Summary

The recent discovery of the neurotoxin, acrylamide, in processed potato products (Tareke et al, 2002) has made health concerns a topic of interest to potato processors, producers and consumers. This issue is particularly important in North Dakota and Minnesota because French fries from this region appear to have higher acrylamide levels than those from other regions (Vernon, 2010).

Acrylamide levels are affected by potato cultivar, processing method, and gene expression. Altering cultural management practices, such as nitrogen fertilization rates, influences the levels of reducing sugars and asparagine, precursors to acrylamide (Mottram et al, 2002; Stadler et al, 2002 and Becalski et al, 2004), and may reduce acrylamide levels immediately. The purpose of this trial was to determine if acrylamide concentrations of processed potato products can be controlled by nitrogen application rate and cultivar selection.

Our research efforts are focused on establishing baseline acrylamide levels in French fries and potato chips made from Russet Burbank and Snowden, compared to the newer processing cultivar releases Alpine Russet, Dakota Trailblazer, and Ivory Crisp, which initial research indicates have lower reducing sugar levels and, in some cases, lower asparagine levels. The effect of nitrogen fertilization rate and tuber storage time on whole-tuber sucrose, glucose, and nitrogen concentrations and French-fry or chip acrylamide concentration for these cultivars were determined. Results for petiole nitrate-nitrogen (nitrate-N) concentrations and tuber yield are also presented.

Project Approach

In 2011 and 2012, five genotypes (Alpine Russet, Dakota Trailblazer, Russet Burbank, Ivory Crisp, and Snowden) were grown at two study sites each year at varying rates of nitrogen application (30, 120, 180, 240, and 300 lbs/ac) to determine the effects of nitrogen management on acrylamide levels and processing quality. In 2011, trials were planted in Becker, MN, and Inkster, ND. In 2012, a field at Park Rapids, MN, was used in place of the Inkster site. Study plots consisted of four rows (the center two being harvested and sampled), 20 feet long. Tubers were spaced one foot apart within each row, with three feet between rows. Prior to planting, all plots were fertilized with a blend of nutrients that included 30 lbs N/ac as monnoammonium phosphate and ammonium sulfate. ESN, a polymer coated urea (44-0-0), was sidedressed at the time of shoot emergence at rates of 0, 90, 150, 210, and 270 lbs N/ac and then hilled in. Petioles were sampled at Becker, four times in 2011 and five times in 2012. Petiole samples were dried and analyzed to determine nitrate-N concentrations.

Tubers from Becker were sorted and graded on-site within a week of harvest. Grading data and quality attribute assessment include total yield and grade, specific gravity, and internal quality assessment for disorders impacting processing quality. Samples were taken for French-frying and chipping soon after grading, and additional samples were taken after three, six and nine months' storage at 46 ˚F. Harvest samples were analyzed for whole-tuber sucrose and glucose concentrations and processed into French fries and chips (depending on the cultivar) at the USDA-ARS Potato Worksite (East Grand Forks, MN). The acrylamide levels (parts per billion of fresh weight) of finished French fries and chips were determined at the University of Minnesota Mass Spectrometry Laboratory.

Goals and Outcomes Achieved

Yield and petiole nitrate-N data are presented for the Becker, MN, site (see appendix). Sugar and acrylamide concentrations have been determined for all sites and all storage times for both 2011 and 2012. We calculated baseline sugar and acrylamide concentrations for all four site-year combinations for each cultivar, averaged (± 1 S.D.) across all nitrogen application rates (Table 1). In addition, for each nitrogen application rate used, we calculated the average baseline values (± 1 S.D.) across both chipping cultivars (Table 2) and all three French-frying cultivars (Table 3).

Nitrogen application rate effects on petiole and tuber N and tuber yield and size

Nitrogen treatment had significant effects on petiole nitrate-N concentration and tuber nitrogen concentration (Tables A1 – A 10), as well as tuber yield and size distribution (Tables A11 – A 20). Petiole nitrate-N concentration increased significantly with nitrogen application rate at all sampling times for all five cultivars in both years. Whole tuber nitrogen concentration increased approximately linearly with nitrogen application rate at Becker in 2011 and 2012.

Marketable yield peaked at a total nitrogen application rate of 180 or 240 lbs/ac (the third- and second-highest rates) for all cultivars in 2011. Different cultivars showed different yield responses to nitrogen application rate in that year (i.e. the treatment-by-cultivar interaction was significant for marketable yield). Alpine Russet, Dakota Trailblazer, and Ivory Crisp each showed a clear peak in marketable yield (at 180 lbs total N/ac for Alpine Russet and Dakota Trailblazer and at 240 lbs total N/ac for Ivory Crisp), while Russet Burbank and Snowden yields plateaued above a certain application rate (180 lbs N/ac for Russet Burbank; 120 lbs N/ac for Snowden). In 2012, marketable yield either increased with nitrogen application rate across the range of application rates used (Alpine Russet, Russet Burbank, and Ivory Crisp) or plateaued at the second-highest rate, 240 lbs total N/ac (Dakota Trailblazer and Snowden). These responses were not significantly different from each other.

In 2011, the percentage of tubers over six or ten ounces increased with increasing nitrogen application rate across the range of application rates evaluated. In contrast, these percentages often peaked at application rates of 180 or 240 lbs N/ac in 2012.

Cultivar effects on petiole and tuber N and tuber yield and size

Petiole nitrate-N concentration and tuber yield and size distribution also differed significantly among the cultivars. In both years and at all storage times, petiole nitrate-N concentration for Alpine Russet was high early in the season (June) but low late in the season (July and August), compared to other cultivars. The opposite was true for Russet Burbank. Ivory Crisp maintained relatively low petiole nitrate-N concentrations throughout the season, while Dakota Trailblazer and Snowden maintained relatively high concentrations.

In terms of whole tuber nitrogen concentration for tubers grown at Becker in 2011, the cultivars ranked as follows: Alpine Russet > Ivory Crisp > Snowden = Russet Burbank > Dakota Trailblazer. The ranking was similar in 2012: Alpine Russet > Ivory Crisp = Russet Burbank > Snowden > Dakota Trailblazer.

In 2011 at Becker, the marketable yields of the cultivars ranked as follows: Dakota Trailblazer > Snowden = Ivory Crisp > Russet Burbank > Alpine Russet. The three newer cultivars had significantly higher percentages of their yield represented by tubers over six or ten ounces than Russet Burbank or Snowden did.

In 2012 at Becker, the marketable yields of the cultivars ranked differently than in 2011: Alpine Russet ≥ Ivory Crisp = Dakota Trailblazer = Snowden ≥ Russet Burbank (with Alpine Russet > Russet Burbank). Again, the new cultivars had significantly greater percentages of their yield in tubers over six ounces than Russet Burbank or Snowden did. The same was true for yield in tubers over ten ounces, except that the percentage for Ivory Crisp was not significantly greater than the percentage for Russet Burbank.

In both years, Alpine Russet and Russet Burbank produced far higher yields of U.S. No. 2 tubers than the other cultivars did. Yield of U.S. No. 2 tubers increased with nitrogen application rate for Russet Burbank, but not for Alpine Russet. Nearly all tubers produced by Dakota Trailblazer, Ivory Crisp, and Snowden were U.S. No. 1 tubers.

Nitrogen application rate effects on tuber sugars and French-fry and chip acrylamide

The relationship between nitrogen application rate and whole-tuber sucrose concentration was inconsistent among years, sites, and storage times, for both the chipping cultivars and the French-frying cultivars.

In contrast to the inconsistent results for whole-tuber sucrose, whole-tuber glucose concentration was usually significantly related to nitrogen application rate, such that higher application rates yielded lower glucose concentrations. At Becker, this relationship was seen at all storage times for both French-frying and frying cultivars in 2011 and for the chipping cultivars in 2012. It was also observed in the frying cultivars in Park Rapids in 2012. However, there was no directional relationship between nitrogen application rate and whole-tuber glucose concentration for the chipping cultivars at either site in 2012, and the relationship between application rate and whole-tuber glucose concentration tended to be positive at Inkster in 2011.

The relationship between the fresh-weight acrylamide concentration of fried products and nitrogen application rate was variable, depending on site, year, cultivar, and storage time.

Because of these interactions, we conclude that, while N management can affect acrylamide in fried potato products, the direction of the response will depend upon each specific situation, precluding the ability to predict the effect of N rate on acrylamide concentrations

Cultivar, preparation, and storage effects on tuber sugars and French-fry and chip acrylamide

Among the French-frying cultivars, Russet Burbank consistently had a lower mean whole-tuber sucrose concentration than Alpine Russet, and it had a lower sucrose concentration than Dakota Trailblazer in all cases except at Inkster after three to nine months in storage. Between the chipping cultivars, Ivory Crisp usually had the lower whole-tuber sucrose concentration, especially at three and six months' storage. For both groups, tuber sucrose concentration generally increased greatly between six and nine months in storage, except that the French-frying cultivars had their highest tuber sucrose concentrations at harvest and three months' storage in 2011.

Dakota Trailblazer had a lower mean whole-tuber glucose concentration than the other two French-frying cultivars at three of the four site-year combinations, the exception being Inkster, where Alpine Russet had the lowest mean glucose concentration. At Becker, the tuber glucose concentrations of the French-frying cultivars tended to increase with storage time. The reverse was seen for Park Rapids tubers, and the glucose concentrations of Inkster tubers fluctuated over time. The two chipping cultivars did not differ consistently in their tuber glucose concentrations until nine months in storage in 2011 and six months in storage in 2012, at which time Snowden began to have far higher glucose concentrations than Ivory Crisp.

Acrylamide concentration was generally significantly higher for the chipping cultivars than for the French-frying cultivars. Only at Park Rapids after three and six months in storage did a French-frying cultivar (Russet Burbank) have significantly higher French-fry acrylamide concentrations than one (Ivory Crisp at six months) or both (at three months) chipping cultivars. This difference in acrylamide concentration between the two preparation methods presumably occurred because the fresh weight of potato chips includes much less water than that of French fries.

Among the French-frying cultivars, Dakota Trailblazer produced the lowest concentrations of acrylamide for most combinations of site, year, and time in storage. The exception was Inkster in 2011, where French fries made from Alpine Russet had significantly lower acrylamide concentrations than those made from Dakota Trailblazer at three and nine months' storage. Overall, Alpine Russet and Dakota Trailblazer in North Dakota and Dakota Trailblazer at Becker consistently produced French fries with lower average acrylamide concentrations than Russet Burbank.

There was no general pattern for how French-fry acrylamide concentrations varied with time in storage. Rather, variation in concentration over storage time depended on cultivar, site, year, and, in some cases, nitrogen fertilizer rate.

The two chipping cultivars produced chips with similar (though often statistically significantly different) acrylamide concentrations through six months' storage at Becker in 2011, at harvest

and at six months' storage at Inkster in 2011, and through three months' storage at both Becker and Park Rapids in 2012. After longer periods of storage, Snowden chips had acrylamide concentrations three to five times as high as Ivory Crisp chips, which showed little tendency for acrylamide concentration to increase with storage time. Both chipping cultivars generally produced their lowest acrylamide concentrations after three or six months storage.

Relationships between acrylamide, tuber nitrogen and sugars, and chip color

Acrylamide concentration was generally positively correlated with whole-tuber glucose concentration for both the French-frying cultivars and the chipping cultivars.

For French-frying cultivars grown in 2012, acrylamide concentration was significantly negatively correlated with the sucrose concentration of tubers from both sites and all four storage times. In contrast, acrylamide concentration was not significantly related to sucrose concentration for either site or any storage time for the chipping cultivars. In 2011, the relationship between sucrose concentration and acrylamide concentration was either insignificant or significantly negative for the French-frying cultivars and significantly positive for the chipping cultivars.

The relationship of whole-tuber nitrogen concentration at harvest to the acrylamide concentration of French fries was significantly positive for French fries made after nine months in storage in 2011. This positive relationship was also significant for French fries made at all storage times except six months (when there was still a trend) in 2012. In contrast, the relationship between chip acrylamide concentration and at-harvest tuber nitrogen tended to become negative with increasing storage time, probably because Snowden had lower tuber nitrogen than Ivory Crisp, but its chip acrylamide levels increased dramatically in the later storage times.

For the chipping cultivars in all sites, both years, and most storage times, acrylamide concentration was positively related to subjective chip color scores (higher scores indicate darker chips) and negatively related to Agtron readings (lower readings indicate darker chips). These relationships were weaker for Inkster in 2011 than for the other site-year combinations, except at nine months' storage, because chip color was less variable at this site.

Objectives achieved

The first objective of this study was to develop baseline values for sugar content, French-fry color, chip color, and acrylamide levels following 0, 3, 6, and 9 months' storage at 46˚F. This objective has been achieved completely.

The second objective was to develop nitrogen management guidelines that improve upon the baseline acrylamide levels determined in the first objective. Because the relationship between nitrogen application rate and acrylamide concentration was inconsistent between sites, between years, and among cultivars, we cannot develop nitrogen management guidelines to reduce acrylamide levels based on the results of this study. However, our data do permit us to make cultivar and storage recommendations to reduce acrylamide levels (see "Lessons Learned"), as

well as cultivar, nitrogen fertilization, and petiole-N recommendations to optimize marketable yield.

Lessons Learned

Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.

The acrylamide concentrations of fried potato products can be controlled, to some extent, through cultivar selection. Tuber glucose concentration is a determinant of final acrylamide concentration. The low glucose concentrations of Dakota Trailblazer tubers, which also yielded low acrylamide levels, suggest that cultivar selection for low tuber glucose concentration may help to reduce acrylamide levels in fried products.

Nitrogen application rate had inconsistent effects on acrylamide concentration. Even when application rate was significantly related to whole-tuber glucose concentration, the relationship between nitrogen application rate and acrylamide concentration was highly variable.

The results of this study indicate good potential to reduce (but not eliminate) acrylamide in fried potato products through cultivar selection, particularly through selection for low-glucose cultivars. However, our results do not suggest that acrylamide concentrations can be controlled in a consistent way by manipulating nitrogen application rate.

Other insights:

- Marketable yield at Becker usually peaked at a nitrogen application rate below the highest rate used in this study (300 lbs N/ac), especially in 2011.
- Alpine Russet and Russet Burbank had high yields of U.S. No. 2 tubers. The other cultivars produced U.S. No. 1 tubers almost exclusively.
- For Russet Burbank, but not for other cultivars, U.S. No. 2 tubers became increasingly prevalent as nitrogen application rate increased.
- Petiole nitrate-N was strongly positively related to nitrogen application rate.
- Nitrogen application rate in the field had inconsistent effects on the acrylamide concentrations of French fries or potato chips.
- Potato cultivar significantly influenced the acrylamide concentrations of French fries and potato chips.
- The newer cultivars (Alpine Russet and Dakota Trailblazer for the French-frying cultivars, Ivory Crisp for the chipping cultivars) yielded lower acrylamide concentrations than the older ones did (Russet Burbank and Snowden).
- For the chipping cultivars, chip acrylamide concentrations were lowest when tubers stored for three or six months were used. For Ivory Crisp, acrylamide concentrations remained low after longer times in storage, but Snowden consistently produced very high acrylamide concentrations by nine months in storage.
- Acrylamide concentration in both French fries and chips was usually positively correlated with whole-tuber glucose concentration.

- Whole-tuber sucrose and nitrogen concentrations were inconsistently correlated with French-fry and chip acrylamide concentration.
- Darker potato chips (as measured subjectively or using an Agtron machine) had higher acrylamide concentrations.

In conclusion, the relationship of acrylamide concentration to nitrogen fertilization rate was found to be highly inconsistent, depending on site, year, cultivar, and storage time. In contrast, there were consistent differences among the cultivars for all site-year combinations. Overall, the new cultivars (Alpine Russet and Dakota Trailblazer for French-frying, Ivory Crisp for chipping) had lower acrylamide concentrations than the older cultivars (Russet Burbank for French-frying, Snowden for chipping). Based on the results of this study, cultivar identity has more clear and consistent effects on the acrylamide concentrations of French fries and chips than does the nitrogen application rate in the field.

Provide unexpected outcomes or results that were an effect of implementing this project.

Nitrogen application rate was expected to be a significant determinant of the acrylamide contents of fried potato products, but this did not prove to be the case. Acrylamide formation can potentially be limited by the concentrations of reducing sugars and asparagine during the Maillard reaction. Because the concentration of asparagine in potato tubers has been shown to be strongly positively related to total tuber nitrogen concentration, and because tuber nitrogen increased with nitrogen application rate at Becker, it was expected that asparagine concentration would be less likely to limit acrylamide formation at higher application rates. As a consequence, acrylamide formation was expected to increase with nitrogen application rate.

The fact that this did not occur may be explained by the potential for the concentrations of reducing sugars to limit acrylamide formation. Where the tuber glucose concentration responded systematically to nitrogen application rate, it decreased as application rate increased. The contradictory trends shown by tuber nitrogen and glucose may have prevented acrylamide formation from showing a consistent directional response to nitrogen treatment.

If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

All goals and outcome measures were achieved in this study.

Beneficiaries

Potato producers growing for the chip and frozen processing markets are potential beneficiaries. Additionally, based on yield and petiole information, not only will their product have potentially less acrylamide formation, but they may find that new cultivars are more sustainable from a production standpoint using less nitrogen to produce a high yield of a high quality crop. This may also positively impact the environment and consumers concerned about leaching. A second group of beneficiaries would include the potato processors. In North Dakota and Minnesota potatoes grown by ND and MN growers are made into French fries and other frozen products at Simplot (Grand Forks, ND), Cavendish Farms (Jamestown, ND), and Lamb-Weston/ConAgra

(Park Rapids, MN). Potatoes grown by MN and ND producers for chipping are processed at Barrel of Fun (Perham, MN), Old Dutch (in Cities area, MN), and also by Frito-Lay plants outside our states. These manufacturing sites benefit if the raw product has low levels of reducing sugars and asparagine, resulting in a finished product with reduced levels of acrylamide. Finally, consumers of frozen processed products including French fries, and snack foods containing potato, such as chips, benefit when acrylamide levels are reduced.

Contact

Carl Rosen
crosen@umn.edu
Department of Soil, Water, and Climate
University of Minnesota

Asunta Thompson
asunta.thompson@ndsu.edu
Department of Plant Sciences
North Dakota State University

Additional Information

This research has been published in the 2012 and 2013 Minnesota Area II Potato Research and Promotion Council and Northern Plains Potato Growers Association (NPPGA) Research Reports. It was also presented to producers at the NPPGA Research Reporting Conference (Grand Forks, ND) in February 2013, the Potato Association of America Annual Meeting (Quebec City, QC) in July 2013, and the Minnesota Area II Educational Conference in November 2013.

Field day events were held in Inkster in August 2012 and in Becker in August 2012 and July 2013. Approximately 200 people attended the Inkster field day, primarily producers and those in the industry. The trial was briefly described in a field day handout, and a brief verbal update was given as to status of the FY11 trials. Approximately 25 growers attended the 2012 field day in Becker. Acrylamide analyses were not complete at the time; only yield and quality results were discussed. Approximately 35 growers attended the 2013 field day, in which 2011 acrylamide results were discussed along with yield and quality results. No formal feedback was received from the attendees at any event, but the potato processors and growers are very interested in the project and the results.

Table 1. Whole-tuber sucrose and glucose concentrations and post-processing acrylamide concentrations of potatoes from each cultivar, averaging (± 1 S.D.) across all nitrogen treatments, from each study site in each year, at harvest and after three, six, and nine months in storage at 46 ˚F.

Site	Year	Cultivar	Sucrose				Glucose				Acrylamide			
			Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months
Becker	2011	Alpine Russet	1.46 ± 0.37	1.29 ± 0.36	0.99 ± 0.26	0.62 ± 0.53	1.54 ± 0.70	2.29 ± 0.78	2.65 ± 1.08	2.88 ± 1.31	434 ± 170	643 ± 390	686 ± 235	1077 ± 524
		Dakota Trailblazer	1.41 ± 0.28	1.18 ± 0.81	0.79 ± 0.63	1.00 ± 0.77	0.41 ± 0.23	0.53 ± 0.25	0.79 ± 0.85	0.88 ± 0.48	120 ± 63	412 ± 370	207 ± 109	333 ± 214
		Russet Burbank	0.95 ± 0.27	1.05 ± 0.38	0.51 ± .018	0.28 ± 0.21	1.71 ± 0.62	2.15 ± 0.75	2.00 ± 1.02	1.96 ± 0.76	576 ± 219	749 ± 363	832 ± 324	874 ± 272
		Ivory Crisp	0.71 ± 0.22	0.64 ± 0.45	0.81 ± 0.77	1.05 ± 1.15	0.22 ± 0.12	0.28 ± 0.20	0.66 ± 0.71	0.93 ± 0.70	3046 ± 1043	2602 ± 1145	1571 ± 975	2285 ± 1208
		Snowden	1.05 ± 0.26	0.83 ± 0.21	1.35 ± 0.68	2.09 ± 1.06	0.22 ± 0.13	0.28 ± 0.23	0.61 ± 0.45	2.84 ± 0.94	3079 ± 1058	1890 ± 829	2353 ± 1042	9549 ± 3104
	2012	Alpine Russet	1.62 ± 0.54	1.64 ± 0.62	1.91 ± 0.57	2.18 ± 1.05	2.70 ± 1.01	2.88 ± 0.89	2.90 ± 0.87	3.00 ± 0.63	1091 ± 298	1326 ± 426	721 ± 518	835 ± 357
		Dakota Trailblazer	1.71 ± 0.43	1.84 ± 0.71	4.64 ± 1.45	15.65 ± 7.09	1.15 ± 0.52	0.60 ± 0.22	0.79 ± 0.35	1.13 ± 0.52	478 ± 201	375 ± 244	135 ± 105	326 ± 161
		Russet Burbank	1.12 ± 0.60	0.93 ± 0.25	1.11 ± 0.34	1.52 ± 0.90	3.27 ± 0.86	2.87 ± 0.81	2.87 ± 0.81	3.91 ± 0.97	1130 ± 385	1351 ± 693	903 ± 684	881 ± 497
		Ivory Crisp	1.01 ± 0.29	0.66 ± 0.40	2.57 ± 0.89	8.04 ± 6.01	0.64 ± 0.27	0.35 ± 0.20	0.45 ± 0.25	0.99 ± 0.46	5503 ± 1596	2055 ± 1003	2705 ± 1010	3586 ± 1502
		Snowden	1.27 ± 0.25	0.87 ± 0.24	2.93 ± 0.47	5.83 ± 1.94	0.61 ± 0.21	0.16 ± 0.07	0.90 ± 0.39	2.21 ± 0.59	5885 ± 1350	1223 ± 468	6167 ± 2303	11080 ± 2714
Inkster	2011	Alpine Russet	1.90 ± 0.44	1.77 ± 0.43	0.99 ± 0.25	0.88 ± 0.31	0.27 ± 0.16	0.36 ± 0.19	0.28 ± 0.46	0.47 ± 0.42	205 ± 141	304 ± 156	304 ± 112	218 ± 109
		Dakota Trailblazer	1.34 ± 0.35	0.77 ± 0.24	0.33 ± 0.17	0.34 ± 0.24	0.48 ± 0.25	0.96 ± 0.54	0.40 ± 0.28	0.71 ± 0.69	212 ± 127	604 ± 348	297 ± 143	325 ± 145
		Russet Burbank	1.03 ± 0.14	0.90 ± 0.22	0.68 ± 0.19	0.59 ± 0.23	0.54 ± 0.20	0.92 ± 0.32	0.55 ± 0.20	0.72 ± 0.28	424 ± 142	737 ± 291	666 ± 185	404 ± 144
		Ivory Crisp	1.50 ± 0.26	0.72 ± 0.27	0.78 ± 0.25	0.95 ± 0.83	0.20 ± 0.14	0.17 ± 0.21	0.06 ± 0.07	0.27 ± 0.45	2682 ± 961	821 ± 182	981 ± 113	812 ± 331
		Snowden	1.38 ± 0.27	0.91 ± 0.17	0.98 ± 0.22	1.78 ± 0.39	0.07 ± 0.04	0.06 ± 0.06	0.04 ± 0.02	0.98 ± 0.38	2131 ± 356	2946 ± 1164	1357 ± 241	3717 ± 1257
Park Rapids	2012	Alpine Russet	2.00 ± 0.54	1.95 ± 0.44	1.98 ± 0.60	2.01 ± 0.80	1.04 ± 0.53	1.11 ± 0.63	0.81 ± 0.62	0.71 ± 0.53	1657 ± 571	933 ± 388	1924 ± 867	656 ± 225
		Dakota Trailblazer	2.16 ± 0.50	2.56 ± 1.07	2.75 ± 0.68	4.77 ± 1.98	0.30 ± 0.20	0.07 ± 0.05	0.08 ± 0.06	0.06 ± 0.04	441 ± 113	308 ± 256	693 ± 455	206 ± 118
		Russet Burbank	0.94 ± 0.32	1.26 ± 0.30	0.76 ± 0.20	0.75 ± 0.16	2.67 ± 0.63	2.86 ± 0.57	2.24 ± 0.30	1.81 ± 0.49	2590 ± 586	2083 ± 835	3826 ± 900	874 ± 237
		Ivory Crisp	1.70 ± 0.49	2.25 ± 0.97	2.70 ± 0.94	7.36 ± 5.21	0.32 ± 0.17	0.08 ± 0.05	0.06 ± 0.04	0.14 ± 0.12	5373 ± 1633	841 ± 248	569 ± 130	1354 ± 537
		Snowden	1.39 ± 0.23	1.81 ± 0.53	3.07 ± 0.68	5.19 ± 1.81	0.57 ± 0.28	0.07 ± 0.04	0.58 ± 0.26	1.09 ± 0.38	5363 ± 1840	707 ± 226	2285 ± 840	4020 ± 860

Table 2. Whole-tuber sucrose and glucose concentrations and post-processing acrylamide concentrations of chipping-variety (Ivory Crisp and Snowden) potatoes from each nitrogen treatment, averaging (± 1 S.D.) across both cultivars, from each study site in each year, at harvest and after three, six, and nine months in storage at 46 ˚F.

Site	Year	Treatment	Sucrose				Glucose				Acrylamide			
			Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months
Becker	2011	30 lbs N/ac (0 as ESN)	0.88 ± 0.45	0.68 ± 0.31	1.05 ± 0.73	1.49 ± 1.11	0.35 ± 0.14	0.50 ± 0.22	1.28 ± 0.93	2.87 ± 1.14	3200 ± 1152	2129 ± 727	3013 ± 1249	7469 ± 3992
		120 lbs N/ac (90 as ESN)	0.87 ± 0.36	0.70 ± 0.21	0.79 ± 0.56	1.14 ± 0.89	0.26 ± 0.13	0.36 ± 0.31	0.56 ± 0.42	1.79 ± 0.86	3197 ± 779	2944 ± 674	1949 ± 799	6857 ± 4486
		180 lbs N/ac (150 as ESN)	0.86 ± 0.24	0.81 ± 0.31	1.41 ± 0.96	1.64 ± 1.38	0.16 ± 0.06	0.26 ± 0.06	0.71 ± 0.42	1.64 ± 1.38	3206 ± 1174	2604 ± 1364	2031 ± 1279	6913 ± 5236
		240 lbs N/ac (210 as ESN)	0.93 ± 0.24	0.65 ± 0.25	1.09 ± 0.50	1.80 ± 1.51	0.18 ± 0.09	0.22 ± 0.08	0.48 ± 0.44	1.57 ± 1.48	2878 ± 667	1565 ± 522	1678 ± 895	4493 ± 3253
		300 lbs N/ac (270 as ESN)	0.82 ± 0.23	0.83 ± 0.63	1.11 ± 1.05	1.81 ± 1.34	0.15 ± 0.09	0.11 ± 0.06	0.28 ± 0.15	1.65 ± 1.39	3222 ± 1009	2224 ± 1131	1498 ± 256	4744 ± 4567
	2012	30 lbs N/ac (0 as ESN)	1.04 ± 0.32	0.83 ± 0.29	2.55 ± 0.86	6.30 ± 2.63	0.61 ± 0.15	0.30 ± 0.18	0.59 ± 0.16	1.50 ± 0.63	4349 ± 882	1592 ± 582	3687 ± 1756	6676 ± 3848
		120 lbs N/ac (90 as ESN)	1.11 ± 0.19	0.81 ± 0.54	3.11 ± 0.81	9.30 ± 8.24	0.73 ± 0.24	0.24 ± 0.14	0.83 ± 0.40	2.01 ± 0.80	5974 ± 1163	1888 ± 1243	4855 ± 2422	7780 ± 4866
		180 lbs N/ac (150 as ESN)	1.19 ± 0.28	0.73 ± 0.30	2.84 ± 0.69	7.31 ± 3.31	0.73 ± 0.16	0.36 ± 0.25	0.88 ± 0.58	1.79 ± 0.74	6881 ± 1352	2118 ± 1070	5232 ± 3789	8563 ± 4915
		240 lbs N/ac (210 as ESN)	1.19 ± 0.38	0.75 ± 0.29	2.65 ± 0.64	6.97 ± 2.71	0.52 ± 0.23	0.20 ± 0.11	0.62 ± 0.34	1.70 ± 0.97	5251 ± 1191	1383 ± 398	5139 ± 2233	7290 ± 4578
		300 lbs N/ac (270 as ESN)	1.17 ± 0.34	0.72 ± 0.30	2.61 ± 0.62	4.65 ± 2.24	0.51 ± 0.32	0.13 ± 0.04	0.47 ± 0.31	1.08 ± 0.79	5985 ± 1569	1131 ± 536	3570 ± 1792	6816 ± 4546
Inkster	2011	30 lbs N/ac (0 as ESN)	1.26 ± 0.08	0.64 ± 0.12	0.83 ± 0.31	1.04 ± 0.61	0.12 ± 0.12	0.06 ± 0.06	0.04 ± 0.03	0.44 ± 0.33	2493 ± 876	1323 ± 738	1159 ± 211	2201 ± 1905
		120 lbs N/ac (90 as ESN)	1.44 ± 0.30	0.95 ± 0.24	0.79 ± 0.20	1.45 ± 0.66	0.08 ± 0.06	0.06 ± 0.04	0.03 ± 0.01	0.43 ± 0.41	1991 ± 460	1561 ± 1094	1050 ± 187	2172 ± 1734
		180 lbs N/ac (150 as ESN)	1.44 ± 0.22	0.81 ± 0.20	0.90 ± 0.29	1.34 ± 0.53	0.12 ± 0.09	0.11 ± 0.12	0.04 ± 0.03	0.75 ± 0.64	2350 ± 591	2011 ± 1350	1226 ± 310	2100 ± 1549
		240 lbs N/ac (210 as ESN)	1.40 ± 0.16	0.80 ± 0.20	0.85 ± 0.22	1.19 ± 0.51	0.19 ± 0.21	0.10 ± 0.09	0.05 ± 0.06	0.41 ± 0.29	2703 ± 710	1886 ± 1506	1169 ± 175	2535 ± 1927
		300 lbs N/ac (270 as ESN)	1.66 ± 0.35	0.87 ± 0.33	1.04 ± 0.21	1.78 ± 1.25	0.17 ± 0.09	0.24 ± 0.31	0.08 ± 0.08	1.09 ± 0.69	2497 ± 1063	2637 ± 1801	1241 ± 404	2315 ± 1940
Park Rapids	2012	30 lbs N/ac (0 as ESN)	1.56 ± 0.26	2.00 ± 1.04	2.58 ± 0.71	7.73 ± 6.42	0.64 ± 0.24	0.09 ± 0.07	0.42 ± 0.41	0.71 ± 0.67	6442 ± 1924	652 ± 181	1545 ± 909	2819 ± 959
		120 lbs N/ac (90 as ESN)	1.50 ± 0.37	2.59 ± 0.83	2.75 ± 0.57	6.93 ± 3.73	0.43 ± 0.15	0.08 ± 0.03	0.25 ± 0.28	0.62 ± 0.51	5424 ± 1797	827 ± 296	1537 ± 1104	2868 ± 1868
		180 lbs N/ac (150 as ESN)	1.47 ± 0.17	1.76 ± 0.68	3.54 ± 1.30	5.65 ± 2.18	0.28 ± 0.19	0.05 ± 0.04	0.33 ± 0.40	0.68 ± 0.71	5870 ± 1824	758 ± 195	1646 ± 1353	2965 ± 1658
		240 lbs N/ac (210 as ESN)	1.67 ± 0.74	1.92 ± 0.62	2.96 ± 0.52	5.39 ± 2.74	0.49 ± 0.35	0.09 ± 0.05	0.32 ± 0.29	0.50 ± 0.49	4345 ± 1824	808 ± 246	908 ± 450	2820 ± 1668
		300 lbs N/ac (270 as ESN)	1.50 ± 0.34	1.89 ± 0.69	2.62 ± 0.59	5.69 ± 4.14	0.38 ± 0.25	0.05 ± 0.03	0.30 ± 0.25	0.57 ± 0.50	4764 ± 1467	793 ± 299	1663 ± 1307	2331 ± 1539

Table 3. Whole-tuber sucrose and glucose concentrations and post-processing acrylamide concentrations of French-frying-variety (Alpine Russet, Dakota Trailblazer, and Russet Burbank) potatoes from each nitrogen treatment, averaging (± 1 S.D.) across all three cultivars, from each study site in each year, at harvest and after three, six, and nine months in storage at 46 ˚F.

Site	Year	Treatment	Sucrose				Glucose				Acrylamide			
			Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months	Harvest	3 months	6 months	9 months
Becker	2011	30 lbs N/ac (0 as ESN)	1.30 ± 0.51	1.16 ± 0.51	0.86 ± 0.54	0.71 ± 0.74	1.69 ± 1.14	2.30 ± 1.28	2.58 ± 1.36	2.33 ± 1.51	321 ± 167	604 ± 381	421 ± 318	578 ± 353
		120 lbs N/ac (90 as ESN)	1.21 ± 0.44	1.29 ± 0.33	0.79 ± 0.44	0.67 ± 0.79	1.32 ± 0.67	1.71 ± 0.33	1.84 ± 1.41	2.33 ± 1.49	338 ± 178	582 ± 397	618 ± 336	753 ± 444
		180 lbs N/ac (150 as ESN)	1.23 ± 0.34	1.24 ± 1.01	0.87 ± 0.62	0.71 ± 0.65	1.09 ± 0.61	1.65 ± 1.01	1.86 ± 1.11	2.05 ± 1.28	461 ± 299	641 ± 496	712 ± 422	937 ± 706
		240 lbs N/ac (210 as ESN)	1.26 ± 0.40	0.94 ± 0.28	0.64 ± 0.27	0.54 ± 0.49	1.08 ± 0.76	1.37 ± 0.90	1.60 ± 1.22	1.52 ± 0.68	339 ± 237	528 ± 352	655 ± 407	847 ± 409
		300 lbs N/ac (270 as ESN)	1.37 ± 0.23	1.21 ± 0.35	0.65 ± 0.26	0.53 ± 0.44	0.92 ± 0.58	1.27 ± 0.66	1.19 ± 0.78	1.31 ± 0.67	426 ± 340	675 ± 382	470 ± 242	693 ± 386
	2012	30 lbs N/ac (0 as ESN)	1.87 ± 0.85	1.95 ± 0.84	2.74 ± 1.84	7.96 ± 9.56	2.88 ± 1.50	2.61 ± 1.68	2.22 ± 1.40	2.49 ± 1.67	727 ± 337	1116 ± 897	417 ± 471	657 ± 696
		120 lbs N/ac (90 as ESN)	1.46 ± 0.57	1.51 ± 0.76	2.56 ± 1.46	7.83 ± 8.27	2.56 ± 1.29	2.36 ± 1.56	2.52 ± 1.51	3.02 ± 1.87	819 ± 393	869 ± 709	722 ± 858	568 ± 251
		180 lbs N/ac (150 as ESN)	1.36 ± 0.45	1.33 ± 0.54	2.36 ± 1.77	5.78 ± 7.66	2.45 ± 1.17	2.07 ± 1.08	2.36 ± 1.16	2.77 ± 1.19	871 ± 499	932 ± 626	506 ± 440	632 ± 368
		240 lbs N/ac (210 as ESN)	1.35 ± 0.43	1.27 ± 0.48	3.01 ± 2.41	5.99 ± 6.74	2.18 ± 1.10	1.79 ± 0.99	1.99 ± 1.09	2.58 ± 0.97	974 ± 433	941 ± 518	737 ± 738	682 ± 341
		300 lbs N/ac (270 as ESN)	1.41 ± 0.40	1.33 ± 0.57	2.22 ± 1.37	5.21 ± 7.38	1.72 ± 0.77	1.71 ± 0.96	1.80 ± 0.98	2.47 ± 1.17	927 ± 394	1110 ± 595	536 ± 336	836 ± 418
Inkster	2011	30 lbs N/ac (0 as ESN)	1.47 ± 0.52	1.24 ± 0.65	0.70 ± 0.32	0.68 ± 0.41	0.32 ± 0.15	0.67 ± 0.54	0.30 ± 0.31	0.72 ± 0.83	189 ± 202	395 ± 298	380 ± 217	269 ± 195
		120 lbs N/ac (90 as ESN)	1.45 ± 0.44	1.25 ± 0.63	0.60 ± 0.23	0.60 ± 0.28	0.39 ± 0.20	0.62 ± 0.33	0.36 ± 0.27	0.63 ± 0.43	306 ± 211	708 ± 411	447 ± 340	383 ± 186
		180 lbs N/ac (150 as ESN)	1.44 ± 0.40	1.24 ± 0.46	0.68 ± 0.26	0.55 ± 0.25	0.53 ± 0.31	0.85 ± 0.50	0.35 ± 0.20	0.53 ± 0.25	298 ± 151	542 ± 245	437 ± 205	302 ± 137
		240 lbs N/ac (210 as ESN)	1.46 ± 0.66	1.01 ± 0.51	0.61 ± 0.34	0.55 ± 0.34	0.49 ± 0.19	0.67 ± 0.46	0.50 ± 0.32	0.58 ± 0.35	289 ± 136	521 ± 256	369 ± 105	333 ± 128
		300 lbs N/ac (270 as ESN)	1.30 ± 0.44	1.00 ± 0.45	0.75 ± 0.51	0.63 ± 0.43	0.42 ± 0.25	0.93 ± 0.46	0.54 ± 0.52	0.70 ± 0.48	299 ± 128	575 ± 371	491 ± 228	293 ± 87
Park Rapids	2012	30 lbs N/ac (0 as ESN)	1.95 ± 0.87	2.27 ± 0.99	1.91 ± 1.17	2.36 ± 1.66	1.65 ± 1.03	1.67 ± 1.38	1.22 ± 0.96	1.08 ± 0.99	1518 ± 964	1393 ± 1070	2524 ± 1414	682 ± 396
		120 lbs N/ac (90 as ESN)	1.75 ± 0.72	1.80 ± 0.98	1.87 ± 1.10	2.79 ± 2.33	1.42 ± 1.16	1.45 ± 1.29	1.11 ± 1.07	1.05 ± 0.95	1480 ± 908	1048 ± 1037	1751 ± 1607	513 ± 269
		180 lbs N/ac (150 as ESN)	1.61 ± 0.69	2.07 ± 0.92	1.75 ± 1.07	3.16 ± 3.11	1.17 ± 1.21	1.14 ± 1.27	0.99 ± 1.04	0.69 ± 0.86	1411 ± 1095	1176 ± 1037	2297 ± 1629	609 ± 342
		240 lbs N/ac (210 as ESN)	1.52 ± 0.47	1.83 ± 0.93	1.85 ± 0.84	2.42 ± 1.67	1.31 ± 1.11	1.45 ± 1.40	0.99 ± 0.96	0.82 ± 0.71	1819 ± 1081	804 ± 538	2055 ± 1187	537 ± 395
		300 lbs N/ac (270 as ESN)	1.69 ± 0.79	1.66 ± 0.32	1.79 ± 0.84	1.91 ± 1.24	1.13 ± 1.13	1.04 ± 1.05	0.92 ± 1.04	0.66 ± 0.65	1587 ± 1083	1074 ± 959	2111 ± 1764	552 ± 329

Appendix

Table A1. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration and harvest tuber N concentration of Alpine Russet potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Petiole NO_3-N Concentration (ppm)				Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]					
		lbs N/ac	P, E	June 20	June 28	July 11	July 26	
1	MAP + AMS	30	30, 0	10197 b	1423 c	181 d	206 c	1.16 c
2	MAP + AMS, ESN	120	30, 90	20449 a	10819 b	2417 c	781 c	1.29 bc
3	MAP + AMS, ESN	180	30, 150	21559 a	12151 b	3032 c	1329 c	1.18 c
4	MAP + AMS, ESN	240	30, 210	21206 a	19265 a	9571 b	3834 b	1.43 b
5	MAP + AMS, ESN	300	30, 270	22655 a	19594 a	14510 a	9299 a	1.62 a
			Significance[3]	*	**	**	**	**
			LSD (0.10)	5769	5653	1369	1199	0.16

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A2. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration and harvest tuber N concentration of Dakota Trailblazer potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Petiole NO_3-N Concentration (ppm)				Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]					
		lbs N/ac	P, E	June 20	June 28	July 11	July 26	
1	MAP + AMS	30	30, 0	8011 c	981 d	379 e	194 d	0.82 c
2	MAP + AMS, ESN	120	30, 90	17102 b	7813 c	3301 d	1092 cd	0.86 c
3	MAP + AMS, ESN	180	30, 150	18381 ab	10133 c	7121 c	2682 c	0.98 b
4	MAP + AMS, ESN	240	30, 210	20606 a	16080 b	9954 b	5071 b	1.07 b
5	MAP + AMS, ESN	300	30, 270	21556 a	20186 a	12828 a	7515 a	1.19 a
			Significance[3]	**	**	**	**	**
			LSD (0.10)	3181	3594	1081	1652	0.12

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A3. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration and harvest tuber N concentration of Russet Burbank potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Petiole NO_3-N Concentration (ppm)				Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]					
		lbs N/ac	P, E	June 20	June 28	July 11	July 26	
1	MAP + AMS	30	30, 0	4415 c	689 e	333 e	112 e	0.79 c
2	MAP + AMS, ESN	120	30, 90	14864 b	5353 d	2919 d	1600 d	1.06 b
3	MAP + AMS, ESN	180	30, 150	17714 a	10181 c	7442 c	4367 c	1.12 ab
4	MAP + AMS, ESN	240	30, 210	19549 a	14070 b	12438 b	6683 b	1.14 ab
5	MAP + AMS, ESN	300	30, 270	19893 a	17249 a	15501 a	9377 a	1.23 a
			Significance[3]	**	**	**	**	**
			LSD (0.10)	2638	2177	1776	1313	0.18

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A4. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration and harvest tuber N concentration of Ivory Crisp potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Petiole NO_3-N Concentration (ppm)				Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]					
		lbs N/ac	P, E	June 20	June 28	July 11	July 26	
1	MAP + AMS	30	30, 0	4032 c	346 d	160 d	100 c	0.98 d
2	MAP + AMS, ESN	120	30, 90	16220 b	5157 c	937 d	275 c	1.09 c
3	MAP + AMS, ESN	180	30, 150	19321 ab	9918 b	4265 c	1721 bc	1.19 b
4	MAP + AMS, ESN	240	30, 210	21115 a	16604 a	8705 b	3536 b	1.20 b
5	MAP + AMS, ESN	300	30, 270	22467 a	16943 a	14872 a	7478 a	1.48 a
			Significance[3]	**	**	**	**	**
			LSD (0.10)	3467	3370	2654	2134	0.07

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A5. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration and harvest tuber N concentration of Snowden potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Petiole NO_3-N Concentration (ppm)				Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]					
		lbs N/ac	P, E	June 20	June 28	July 11	July 26	
1	MAP + AMS	30	30, 0	3556 c	573 d	260 e	306 d	1.11
2	MAP + AMS, ESN	120	30, 90	15618 b	6535 c	2766 d	1490 c	1.21
3	MAP + AMS, ESN	180	30, 150	20797 a	11989 b	6237 c	2561 b	1.03
4	MAP + AMS, ESN	240	30, 210	22039 a	16424 a	10604 b	6679 a	1.14
5	MAP + AMS, ESN	300	30, 270	20957 a	18960 a	14041 a	7535 a	1.16
			Significance[3]	**	**	**	**	NS
			LSD (0.10)	3843	2691	1907	1003	--

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A6. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration of Alpine Russet potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Petiole NO3-N Concentration (ppm)					Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]						
		lbs N/ac	P, E	June 11	June 28	July 10	July 24	August 9	
1	MAP + AMS	30	30, 0	2997 c	505 d	140 c	267 b	44 b	1.35 b
2	MAP + AMS, ESN	120	30, 90	14956 b	5566 c	658 bc	312 b	125 b	1.39 b
3	MAP + AMS, ESN	180	30, 150	17786 b	8065 bc	1593 b	1257 ab	493 ab	1.41 b
4	MAP + AMS, ESN	240	30, 210	17560 b	9308 b	1392 bc	582 b	160 b	1.46 b
5	MAP + AMS, ESN	300	30, 270	22296 a	13045 a	3032 a	2761 a	1180 a	1.60 a
			Significance[3]	**	**	*	++	++	*
			LSD (0.10)	3224	3562	1405	1639	845	0.13
			Linear contrast	**	**	**	*	*	**
			Quadratic contrast	NS	NS	NS	NS	NS	NS

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A7. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration of Dakota Trailblazer potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Petiole NO3-N Concentration (ppm)					Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]						
		lbs N/ac	P, E	June 11	June 28	July 10	July 24	August 9	
1	MAP + AMS	30	30, 0	4653 c	780 e	264 d	490 c	28 b	0.99 c
2	MAP + AMS, ESN	120	30, 90	16726 b	7196 d	611 cd	428 c	155 b	0.99 c
3	MAP + AMS, ESN	180	30, 150	17874 b	10307 c	1795 c	897 c	268 b	1.12 bc
4	MAP + AMS, ESN	240	30, 210	21451 a	15100 b	5498 b	3017 b	536 b	1.25 ab
5	MAP + AMS, ESN	300	30, 270	19420 ab	19332 a	8677 a	5967 a	2487 a	1.30 a
			Significance[3]	**	**	**	**	*	*
			LSD (0.10)	3479	2991	1370	1864	1381	0.16
			Linear contrast	**	**	**	**	**	**
			Quadratic contrast	**	NS	**	**	++	NS

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A8. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration of Russet Burbank potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Petiole NO3-N Concentration (ppm)					Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]						
		lbs N/ac	P, E	June 11	June 28	July 10	July 24	August 9	
1	MAP + AMS	30	30, 0	2833 c	454 d	75 c	307 a	57 b	1.14 b
2	MAP + AMS, ESN	120	30, 90	12164 b	5325 c	1060 c	1052 d	519 b	1.31 a
3	MAP + AMS, ESN	180	30, 150	15457 a	9585 b	2334 bc	2904 c	898 b	1.39 a
4	MAP + AMS, ESN	240	30, 210	16359 a	12244 ab	3699 b	5711 b	1117 b	1.38 a
5	MAP + AMS, ESN	300	30, 270	16711 a	14740 a	7358 a	10723 a	3074 a	1.34 a
			Significance[3]	**	**	**	**	*	*
			LSD (0.10)	3237	2926	2299	1430	1454	0.13
			Linear contrast	**	**	**	**	**	**
			Quadratic contrast	**	NS	++	**	NS	++

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A9. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration of Ivory Crisp potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Petiole NO3-N Concentration (ppm)					Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]						
		lbs N/ac	P, E	June 11	June 28	July 10	July 24	August 9	
1	MAP + AMS	30	30, 0	871 d	1294 d	68 b	298 b	29	1.20 cd
2	MAP + AMS, ESN	120	30, 90	12142 c	2962 d	226 b	558 b	26	1.18 d
3	MAP + AMS, ESN	180	30, 150	16665 b	6745 c	647 b	232 b	49	1.34 bc
4	MAP + AMS, ESN	240	30, 210	15331 b	11160 b	2292 b	1111 b	67	1.39 b
5	MAP + AMS, ESN	300	30, 270	21878 a	15671 a	6005 a	6599 a	837	1.61 a
			Significance[3]	**	**	**	**	NS	**
			LSD (0.10)	2939	3617	2579	2575	--	0.16
			Linear contrast	**	**	**	**	++	**
			Quadratic contrast	*	++	*	**	NS	++

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A10. Effect of nitrogen rate from ESN fertilizer on petiole nitrate-N concentration of Snowden potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Petiole NO3-N Concentration (ppm)					Tuber Nitrogen (%)
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]						
		lbs N/ac	P, E	June 11	June 28	July 10	July 24	August 9	
1	MAP + AMS	30	30, 0	2949 c	1128 d	554 c	466 c	54 b	1.09
2	MAP + AMS, ESN	120	30, 90	13087 b	4441 c	373 c	257 c	87 b	1.18
3	MAP + AMS, ESN	180	30, 150	17482 a	9609 b	1904 bc	1012 c	173 b	1.31
4	MAP + AMS, ESN	240	30, 210	18233 a	10671 b	3298 b	5284 b	795 b	1.36
5	MAP + AMS, ESN	300	30, 270	19916 a	17810 a	7907 a	13843 a	3771 a	1.19
			Significance[3]	**	**	**	**	**	NS
			LSD (0.10)	2692	2739	2006	2191	872	--
			Linear contrast	**	**	**	**	**	NS
			Quadratic contrast	**	NS	**	**	**	++

[1]MAP = monoammonium phosphate; AMS = ammonium sulfate; ESN = Environmentally Smart Nitrogen.

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A11. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Alpine Russet potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	51.3	168.4 a	82.7 c	34.1 b	1.6 c	338.1 c	154.3 c	132.5 a	286.8 c	37.1 b	11.5 c
2	MAP + AMS, ESN	120	30, 90	42.5	150.5 a	140.1 ab	66.5 a	30.3 b	429.8 ab	293.6 ab	93.7 ab	387.3 ab	55.8 a	23.4 b
3	MAP + AMS, ESN	180	30, 150	50.7	150.3 a	154.1 a	75.7 a	42.5 b	473.3 a	339.7 a	82.9 b	422.5 a	57.8 a	25.2 b
4	MAP + AMS, ESN	240	30, 210	53.8	123.4 ab	128.8 ab	79.7 a	41.9 b	427.6 ab	286.4 b	87.4 b	373.8 ab	59.9 a	29.6 ab
5	MAP + AMS, ESN	300	30, 270	40.6	96.6 b	113.9 bc	56.5 ab	76.7 a	384.3 bc	266.7 b	77.0 b	343.7 b	64.7 a	35.1 a
			Significance[3]	NS	++	*	*	**	*	**	++	**	**	**
			LSD (0.10)	--	46.5	32.1	23.2	24.4	59.9	51.8	39.2	50.3	10.6	9.6

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A12. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Dakota Trailblazer potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	20.6 bc	162.7 a	213.6 bc	26.1 b	0.9 c	424.0 c	399.8 c	3.6	403.3 c	56.2 c	6.1 c
2	MAP + AMS, ESN	120	30, 90	19.5 c	121.9 bc	260.3 ab	88.8 a	21.7 b	512.1 ab	491.2 ab	1.4	492.6 ab	72.4 a	21.5 b
3	MAP + AMS, ESN	180	30, 150	29.1 a	135.4 ab	272.9 a	97.3 a	12.4 bc	547.0 a	516.4 a	1.4	517.8 a	69.8 ab	19.9 b
4	MAP + AMS, ESN	240	30, 210	27.8 ab	159.6 ab	196.1 c	115.9 a	24.4 ab	523.8 ab	496.0 ab	0.0	496.0 ab	64.1 b	26.2 ab
5	MAP + AMS, ESN	300	30, 270	32.1 a	94.1 c	213.4 bc	114.7 a	44.3 a	498.7 b	465.7 b	1.0	466.6 b	74.7 a	32.0 a
			Significance[3]	*	*	++	**	*	**	**	NS	**	**	**
			LSD (0.10)	7.7	38.6	57.2	27.8	20.1	41.9	46.0	--	46.2	7.1	6.6

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A13. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Russet Burbank potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	141.0 a	231.1	56.6	1.1 c	0.0 c	429.8 b	232.2	56.6	288.8 b	12.9 c	0.3 c
2	MAP + AMS, ESN	120	30, 90	112.2 b	234.3	135.5	7.6 c	5.0 bc	494.6 ab	320.2	62.1	382.4 a	30.2 b	2.6 c
3	MAP + AMS, ESN	180	30, 150	107.2 b	243.7	143.7	38.4 b	10.0 bc	543.0 a	363.2	72.6	435.8 a	35.4 ab	8.9 b
4	MAP + AMS, ESN	240	30, 210	102.4 bc	208.3	139.4	50.5 ab	14.4 ab	515.0 a	315.9	96.7	412.6 a	39.6 ab	12.6 b
5	MAP + AMS, ESN	300	30, 270	82.0 c	177.3	148.2	68.7 a	25.3 a	501.5 ab	304.0	115.5	419.5 a	48.1 a	19.3 a
			Significance[3]	*	NS	NS	**	*	++	NS	NS	*	**	**
			LSD (0.10)	24.8	--	--	20.7	12.7	77.2	--	--	79.1	14.3	6.3

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A14. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Ivory Crisp potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0 - 3 oz (0 - 2.25")	3 - 6 oz (2.25 - 2.75")	6 - 10 oz (2.75 - 3.25")	10 - 14 oz (3.25 - 3.75")	> 14 oz (> 3.75")	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	41.6	147.1 a	135.6 d	36.2 c	7.6 c	368.1 c	326.4 c	0.0	326.4 c	47.8 b	11.4 c
2	MAP + AMS, ESN	120	30, 90	30.4	125.7 ab	215.4 b	80.2 bc	18.4 bc	470.1 b	438.9 b	0.8	439.7 b	66.1 a	20.0 bc
3	MAP + AMS, ESN	180	30, 150	33.6	137.2 ab	185.2 bc	108.7 ab	40.1 ab	504.8 ab	470.7 ab	0.5	471.2 ab	65.9 a	28.9 b
4	MAP + AMS, ESN	240	30, 210	26.4	118.4 bc	254.8 a	104.9 ab	41.5 ab	546.1 a	516.7 a	2.9	519.6 a	73.5 a	26.6 b
5	MAP + AMS, ESN	300	30, 270	25.5	89.9 c	176.9 c	128.6 a	67.0 a	487.9 b	461.6 ab	0.8	462.4 ab	76.3 a	40.2 a
			Significance[3]	NS	*	**	*	*	**	**	NS	**	**	**
			LSD (0.10)	--	28.7	35.3	47.4	30.6	53.3	59.6	--	59.7	11.0	10.6

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A15. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Snowden potato plants grown at Becker, MN, in 2011.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0 - 3 oz (0 - 2.25")	3 - 6 oz (2.25 - 2.75")	6 - 10 oz (2.75 - 3.25")	10 - 14 oz (3.25 - 3.75")	> 14 oz (> 3.75")	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	76.1 bc	240.7	81.2 b	12.1 d	1.8 c	411.9 b	335.7 b	0.0	335.7 b	23.0 c	3.3 d
2	MAP + AMS, ESN	120	30, 90	72.8 c	275.8	164.8 a	25.2 cd	1.6 c	540.3 a	467.5 a	0.0	467.5 a	35.2 b	4.9 cd
3	MAP + AMS, ESN	180	30, 150	75.3 bc	243.8	203.2 a	32.5 c	5.1 bc	559.9 a	484.6 a	0.0	484.6 a	43.1 ab	6.7 c
4	MAP + AMS, ESN	240	30, 210	90.3 ab	231.5	181.2 a	48.3 b	13.3 ab	564.6 a	474.3 a	0.0	474.3 a	43.2 a	10.9 b
5	MAP + AMS, ESN	300	30, 270	96.4 a	210.7	173.1 a	64.9 a	16.9 a	562.0 a	464.0 a	1.6	465.6 a	44.9 a	14.5 a
			Significance[3]	*	NS	**	**	*	**	**	NS	**	**	**
			LSD (0.10)	16.0	--	47.5	14.8	8.9	53.1	53.2	--	53.5	8.0	2.6

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A16. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Alpine Russet potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	43.2 a	126.6 a	103.6 b	53.3 c	11.7 d	338.4 d	92.0 c	203.3 b	295.2 d	49.7 c	19.2 c
2	MAP + AMS, ESN	120	30, 90	25.4 b	112.2 a	158.2 a	153.7 b	112.1 c	561.6 c	215.3 b	320.9 a	536.2 c	75.5 b	47.3 b
3	MAP + AMS, ESN	180	30, 150	20.4 b	66.6 b	159.1 a	182.5 a	156.5 b	585.0 bc	251.6 ab	313.1 a	564.7 bc	85.1 a	57.8 a
4	MAP + AMS, ESN	240	30, 210	15.3 b	73.5 b	153.3 a	179.5 ab	190.5 ab	612.1 ab	295.8 a	301.0 a	596.8 ab	85.5 a	60.4 a
5	MAP + AMS, ESN	300	30, 270	24.8 b	82.6 b	141.5 a	187.6 a	202.7 a	639.2 a	291.9 a	322.6 a	614.4 a	82.9 a	60.6 a
			Significance[3]	**	**	*	**	**	**	**	*	**	**	**
			LSD (0.10)	11.1	25.9	32.9	26.5	41.1	33.9	61.5	58.0	38.7	4.7	7.9
			Linear contrast	**	**	*	**	**	**	**	*	**	**	**
			Quadratic contrast	*	NS	NS	**	**	**	**	*	**	**	**

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A17. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Dakota Trailblazer potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/A	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	17.2	110.2 b	157.6 c	37.2 b	16.1 b	338.3 c	319.2 c	1.9	321.1 b	61.8 b	15.6 b
2	MAP + AMS, ESN	120	30, 90	7.8	119.6 b	218.4 ab	143.8 a	42.9 b	532.5 b	504.5 b	20.2	524.7 a	76.1 a	34.9 a
3	MAP + AMS, ESN	180	30, 150	11.3	107.4 b	245.2 a	145.9 a	42.7 b	552.5 ab	540.3 a	0.9	541.2 a	78.4 a	34.0 a
4	MAP + AMS, ESN	240	30, 210	17.2	200.3 a	184.4 bc	143.2 a	25.5 b	570.6 a	550.0 a	3.5	553.4 a	61.6 b	29.4 a
5	MAP + AMS, ESN	300	30, 270	15.0	112.1 b	208.3 abc	133.7 a	92.1 a	561.1 ab	545.3 a	0.9	546.1 a	77.1 a	40.1 a
			Significance[3]	NS	*	++	**	**	**	**	NS	**	*	*
			LSD (0.10)	--	58.9	55.4	46.3	31.8	29.8	34.0	--	31.6	11.1	13.1
			Linear contrast	NS	NS	*	**	NS	**	**	NS	**	NS	++
			Quadratic contrast	NS	++	NS	*	*	**	**	NS	**	NS	*

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A18. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Russet Burbank potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0-3 oz	3-6 oz	6-10 oz	10-14 oz	> 14 oz	Total	#1 > 3 oz	#2 > 3 oz	Total Marketable	> 6 oz	> 10 oz
		lb N/A	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	97.8 a	199.8	69.8 c	15.0 c	1.0 c	383.4 c	101.9 c	183.6	285.6 c	21.8 c	3.9 c
2	MAP + AMS, ESN	120	30, 90	68.0 ab	239.2	131.8 b	72.6 b	21.4 bc	533.0 b	221.5 b	243.5	465.0 b	41.9 b	17.1 b
3	MAP + AMS, ESN	180	30, 150	47.5 b	169.1	149.7 b	105.5 ab	81.9 a	553.7 ab	221.3 b	284.9	506.2 ab	61.7 a	35.1 a
4	MAP + AMS, ESN	240	30, 210	62.2 b	191.1	212.6 a	110.0 ab	42.5 b	618.3 ab	260.2 ab	295.9	556.1 ab	59.0 a	24.6 ab
5	MAP + AMS, ESN	300	30, 270	57.8 b	182.1	176.1 ab	131.5 a	86.1 a	633.6 a	298.7 a	277.1	575.8 a	61.6 a	33.8 a
			Significance[3]	*	NS	**	**	**	**	**	NS	**	**	**
			LSD (0.10)	30.1	--	47.9	46.5	34.4	97.0	40.2	--	91.8	14.1	12.3
			Linear contrast	**	NS	**	**	**	**	**	*	**	**	**
			Quadratic contrast	NS	NS	**	**	NS	**	**	NS	**	**	++

[1]ESN (Environmentally Smart Nitrogen, Agrium, Inc.) = 44-0-0; MAP (monoammonium phosphate) = 11-50-0; AMS (ammonium sulfate) = 21-0-0-22

[2]P=planting, E=emergence/hilling.

[3]NS = Non significant; ++, *, ** = Significant at 10%, 5%, and 1%, respectively.

Treatments that have the same letter within a column are not significantly different from each other.

Table A19. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Ivory Crisp potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0 - 3 oz (0 - 2.25")	3 - 6 oz (2.25 - 2.75")	6 - 10 oz (2.75 - 3.25")	10 - 14 oz (3.25 - 3.75")	> 14 oz (> 3.75")	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/A	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	47.9 a	170.6	108.9 b	24.4 c	1.7 c	353.4 d	305.5 d	0.0	305.5 c	38.6 b	7.6 c
2	MAP + AMS, ESN	120	30, 90	31.8 b	175.2	187.9 a	102.5 b	36.0 b	533.4 c	499.4 c	2.3	501.6 b	59.3 a	24.6 b
3	MAP + AMS, ESN	180	30, 150	33.5 b	153.5	191.6 a	142.6 ab	36.0 b	557.2 bc	522.9 bc	0.8	523.7 b	66.5 a	31.6 ab
4	MAP + AMS, ESN	240	30, 210	37.0 b	169.0	237.2 a	124.6 ab	47.1 b	614.9 ab	576.4 ab	1.4	577.8 ab	66.4 a	27.6 ab
5	MAP + AMS, ESN	300	30, 270	39.9 ab	155.3	229.7 a	154.4 a	75.6 a	654.9 a	615.0 a	0.0	615.0 a	70.2 a	35.1 a
			Significance[3]	*	NS	*	**	**	**	**	NS	**	**	**
			LSD (0.10)	8.5	--	63.7	48.0	22.3	72.3	76.2	--	76.3	11.1	8.9
			Linear contrast	*	NS	*	**	*	**	**	NS	**	**	**
			Quadratic contrast	NS	NS	**	*	**	**	**	NS	**	**	**

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

Table A20. Effect of nitrogen rate from ESN fertilizer on tuber yield and size distribution for Snowden potato plants grown at Becker, MN, in 2012.

Nitrogen Treatments				Tuber Yield										
Treatment #	Nitrogen Source[1]	Nitrogen Rate	Nitrogen Timing[2]	0 - 3 oz (0 - 2.25")	3 - 6 oz (2.25 - 2.75")	6 - 10 oz (2.75 - 3.25")	10 - 14 oz (3.25 - 3.75")	> 14 oz (> 3.75")	Total	# 1 > 3 oz	# 2 > 3 oz	Total marketable	> 6 oz	> 10 oz
		lb N/ac	P, E	cwt / A						cwt / A			%	
1	MAP + AMS	30	30, 0	73.0	188.0 b	85.3 c	12.0 b	1.0	359.2 d	286.2 d	0.0 b	286.2 d	26.9 c	3.6 b
2	MAP + AMS, ESN	120	30, 90	79.1	290.7 a	152.3 b	15.4 b	0.7	538.1 c	459.0 c	0.0 b	459.0 c	31.0 bc	3.0 b
3	MAP + AMS, ESN	180	30, 150	72.8	278.8 a	179.1 ab	52.1 ab	2.2	585.0 b	511.5 b	0.7 a	512.2 b	39.9 ab	9.3 ab
4	MAP + AMS, ESN	240	30, 210	61.7	298.3 a	213.5 a	87.2 a	8.0	668.7 a	607.0 a	0.0 b	607.0 a	46.2 a	14.2 a
5	MAP + AMS, ESN	300	30, 270	79.4	318.3 a	219.7 a	54.5 ab	6.9	678.8 a	599.4 a	0.0 b	599.4 a	41.4 ab	9.1 ab
			Significance[3]	NS	**	**	*	NS	**	**	++	**	*	++
			LSD (0.10)	--	39.8	46.2	48.3	--	31.1	50.0	0.5	49.9	10.5	8.1
			Linear contrast	NS	**	**	*	NS	**	**	*	**	**	*
			Quadratic contrast	NS	**	**	NS	NS	**	**	++	**	*	NS

[1]MAP = monoammonium phosphate (11-46-0); AMS = ammonium sulfate (21-0-0-22); ESN = Environmentally Smart Nitrogen (44-0-0).

[2]P = planting; E = emergence/hilling.

[3]NS = non-significant; ++ = significant at 10%; * = significant at 5%; ** = significant at 1%.

Treatments that have the same letter within a column are not significantly different from each other.

PROJECT 10: LOCAL FOODS INITIATIVE

Final Report

Project Summary

The North Dakota Department of Agriculture (NDDA) began promoting specialty crops as local foods in August of 2008 through the Going Local North Dakota local foods initiative. We have seen an increased interest in buying fruits and vegetables from farmers; and growing more specialty crops on small to mid-sized family farms.

Increased interest in local foods and building up the economy could not be overstated. With the economic downturn and local foods movement, more and more people are looking to "local" as a lifestyle. With creativity and support, the potential for an agriculture state like North Dakota to cultivate new enterprises surrounding fruit orchards, vegetable production is limitless. You can see the interest in local growing through the number of donations from gardeners to the Hunger Free North Dakota Garden project; the interactions with our social networking communities; the implementation of farm-to-school programs in local schools, the increase in the number of school garden grant applications and awardees; the increase in CSA programs, farmers markets and community gardens; and the increased requests for information about direct marketing to our office.

Funding from the SCBGP is helping the NDDA achieve the following goals:

1. Increase the number of Farm to Cafeteria (Farm to School) programs.
2. Increase participation in North Dakota's local foods conference.
3. Utilize the mobile foods processing unit to promote specialty crop opportunities in communities.
4. Increase participation in social networking.
5. Document vegetable and fruit production in the state through the Hunger Free ND Garden project.
6. Provide technical assistance to communities working their local foods strategic plans.
7. Provide mini grants to communities to develop an orchard in their community.

Project Approach

The Going Local Initiative utilized grant money to connect with North Dakota communities, large and small, and assist them in growing, consuming and supporting local products. We worked with education facilities, civic organizations, groups, associations, businesses, etc. to reach our goals and objectives for this grant. By bringing groups like this together, we opened communication lines and helped show the strength in teamwork.

To ensure the money from the grant was used to solely enhance the competitiveness of specialty crops, the Department of Agriculture employs four marketing specialists. One specialist, funded through this grant, works solely on specialty crop promotions and production and tracks time each month of the Local Foods Initiative. The other marketing specialists work on non-specialty

crop aspects of the Local Foods Imitative and are funded through the North Dakota Department of Agriculture.

Goals and Outcomes Achieved

1. The Going Local initiative has and continues to provide support to the communities working on their strategic plans while providing assistance and education to additional individuals, groups, nonprofits, universities and agencies looking to bring specialty crop production and awareness into their county or community. We will accomplish success by providing assistance to five North Dakota communities utilizing and implementing their local foods strategic plans.
    a. Work continues with the Bismarck Food Co-op to reach their goals. They were awarded an Agriculture Products Utilization Commission (APUC) grant to move forward with a feasibility study. The study concluded that the Bismarck/Mandan area has the population and interest to sustain a food co-op. We will continue to follow their progress as a local food co-op forms in Bismarck/Mandan community. Population of Bismarck & Mandan 83,729.
        i. Bismarck local foods committee started a second farmers market in 2012. They held three separate markets to draw attention to a new market location and concept.
    b. Fargo area is working to develop a downtown market. We have worked with the group to offer suggestions, guidance and plans for their market. The local foods specialist spoke to an active Fargo group to encourage local foods support. Population of Fargo 109,799
        i. Fargo community's local food strategies include adding an additional market downtown. They have a plan drafted. Their hopes of opening the new market in 2012 didn't happen, but they continue to utilize their local food plan to move into the upcoming year.
    c. Williston Downtown Farmers Market opened this year with help and guidance from the Local Foods Initiative. Through several meetings, phone conversations and Q&A time, the Williston market is open and a success. Population of Williston 18,532.
        i. Williston community's local food strategies also include adding an additional market to their downtown area. With the population growth in the oil company the new market will form as a resource for the community and also as an opportunity to teach the community about local foods and specialty crop agriculture in North Dakota. Their market was opened the summer of 2012, and they had a successful season.
    d. Turtle Mountain Community College in Belcourt, held a two-day workshop for community members interested in starting or who have started small agriculture-related businesses. The main focus was specialty crop businesses in the form of farmers market vendors, CSAs and direct market sales encouraging farm to fork. The local foods specialist spent the afternoon of July 10, 2012 with a group of 22 individuals to share what the state is doing, offer ideas and provide hands-on activity

to engage the participants. The group spent their second day touring several farms in the area.

e. The Valley City community is working on their Farm to School planning per their local foods strategic planning. The NDDA has been instrumental in planning and grant development to help their community become a F2S leader.
    i. The Valley City community's local foods plan includes Farm to School initiatives which continue to make them a leader in the region. The school sources local food from market vendors and local farmers. The local foods are served in the cafeteria and students are educated on the source of the food.

f. In addition to help with F2S, students from Valley City State University took part in a squash harvest event to benefit the Hunger Free ND Garden Project. The NDDA's mobile food processing unit was on hand to cook squash and offer taste testing for the students and volunteers. This event was held in September and was an excellent opportunity to bring the community together. The group harvested thousands of pounds of squash and cooked enough for over 200 volunteers.

g. The Hunger Free ND Garden Project has been a part of many communities working to generate more access to fresh, local foods. This is an ongoing project. In 2012 LaMoure and Dickey County had several farmers grow sweet corn, squash and melons for the local and regional food banks. Over 10,000 pounds of sweet corn and 1,000 pounds of squash were donated from these two counties. See additional information section-Appendix A.

h. Farmers Market Day at the Capitol was held on August 7, 2012. We had about 20 farmers market vendors line the front loop of the capitol building to sell and promote their fresh produce to hundreds of capitol workers and community shoppers. Local foods lunch was served from the Capitol Café and Fireflour Pizza. We had an excellent turnout for the event and successful conversations around specialty crops. See Appendix B.

i. The following communities have received support from "The Going Local Initiative."
    i. The Bismarck/Mandan community has been working on their local food strategies and have accomplishments including:
        1. Bismarck/Mandan Food Co-op completed a feasibility study in 2012 and work continues on their project.
        2. Bismarck local foods committee started a second farmers market in 2012. They held three separate markets to draw attention to a new market location and concept.
    ii. Fargo community's local food strategies include adding an additional market downtown. They have a plan drafted. Their hopes of opening the new market in 2012 didn't happen, but they continue to utilize their local food plan to move into the upcoming year.
    iii. Williston community's local food strategies also include adding an additional market to their downtown area. With the population growth in the oil company the new market will form as a resource for the community and also as an opportunity to teach the community about local foods and specialty crop

agriculture in North Dakota. Their market was opened the summer of 2012, and they had a successful season.

iv. The Valley City community's local foods plan includes Farm to School initiatives which continue to make them a leader in the region. The school sources local food from market vendors and local farmers. The local foods are served in the cafeteria and students are educated on the source of the food.

v. LaMoure and Dickey county local foods strategic plans include supplying local foods to the less fortunate in their community. In 2012 they had several farmers grow sweet corn, squash and melons for the local and regional food banks. Over 10,000 pounds of sweet corn and 1,000 pounds of squash were donated from these two counties.

2. The mobile processing unit will continue to be a stage for the local foods initiative and a promotional piece for agriculture in the state. It will be used for a minimum of four educational seminars throughout the state and four specialty crop opportunities at community events and on-farm gatherings.

   a. The mobile food unit was used for the Northern Pulse Conference held in Minot. We cooked and sampled pulse recipes out of the unit, The event has become an annual outing for the mobile food unit, and a way to provide specialty crop outreach.
   b. The mobile food unit was the focal point for the ND Nutrition Council's Annual Conference in Fargo on June 14 – 15. The group held a local foods social where tours of the unit were available during the evening event along with discussion on how the unit can be utilized to promote specialty crops across the state. Karen Ehrens organized and ran the event.
   c. Honey Lovers, Inc. used the unit from June 20 – July 2 to process honey product for their small Pride of Dakota business. The honey used in their recipes is 100% North Dakota honey.
   d. Friends & Neighbors Day at the Mandan USDA Research Center showcased the unit on July 19th to promote specialty crop opportunities in the region and state. About 800 participants enjoyed and many took in the mobile unit and NDDA Ag Exhibit educating about the many specialty crops in our area. See Appendix C.
   e. July 21 was an excellent day at the Go! Bismarck Mandan Saturday Markets and More Farmers Market. The mobile food unit was the stage for local foods cooking demonstrations by chef Duane Ehrens. Attendees were able to see how farmers market fruits and vegetables can be transformed into wonderful family meals. Attendance for the market was around 75 individuals stopping to learn more about cooking with local foods.
   f. The NDDA, Great Plains Food Bank and volunteers from Valley City State University harvested squash to donate to the food pantries throughout the state. They utilized the mobile food unit to engage students in local foods and did a squash taste testing out in the field.

3. The *Developing a Community Orchard in North Dakota* is a remarkable document to provide assistance to local communities and individuals interested in starting an orchard. Success will be accomplished by seeing four communities, groups or individuals utilize the new orchard document to help create a North Dakota orchard event or project. See Appendix D.
    a. The orchard grant project awarded five grants to communities developing orchards across the state. The grants were awarded in May and work has started on the orchards in the region. We will continue to share information on the project as the groups work towards their goal of more orchards in ND.

The community orchards include:

1. *Aneta Specialty Crop Group – Create a community orchard and garden for the city of Aneta. This partnership project involves the Aneta Homemaker's Club, Jolly Haymakers 4-H Club, Aneta Booster Club and the Aneta Specialty Crop Group made up of Bill Miller, Janice Mills, Fred Lukens, Jane Lukens, Randy Johnson and Donna Schaeffer. The project will work with Nelson County Food Bank, Parkview Health Center and Dakota Prairie School for food security, school nutrition and education. The orchard will also be utilized as a community activity center and is walking distance from town. Population 220*
2. *City of Sheyenne Tree Board – The Sheyenne Town and County Civic Association, Trail Riders 4-H and Sheyenne-Oberon Area Ministries have partnered with the Horizon Program's G.R.I.T. (growth renewal, imagination, teamwork) community group to bring a community orchard to Sheyenne. This orchard grant will help grow the Hunger Free ND Garden Project the community has been working on for the past two years. By incorporating fruit trees they will ensure long-term sustainability and a fruit-filled future for Sheyenne. Population 205*
3. *Elgin/New Leipzig Public School (Marie Klein) – The grant money will be used to build additional boxes to establish apple trees, strawberries, raspberries and rhubarb at the existing O.W.L.S. Tree Project located at the Elgin Public School. The area provides educational opportunities for the community and school with plans of donating a portion of the orchard harvest to help provide healthy, low-cost food for the school's Eating Wise Program. Student enrollment: 145*
4. *Cankdeska Cikana Community College Land Grant Program (CCCC) – Funding from the Orchard Grant will help CCCC integrate fruit trees and bushes into the campus environment. The edible landscape will serve as an outdoor classroom for youth programs, college curriculum, and community workshops. Community members will learn about the cultural significance of fruits and how they can be used to encourage healthy eating habits. Enrollment: 250*
5. *North Dakota State University – The Orchard Grant will benefit the Dragonfly Garden in Bismarck. The Dragonfly Garden is a 1.5 acre outdoor classroom located at United Tribes Technical College in Bismarck where families can learn how to grow healthy food and enjoy the beauty of nature. Educational programs are conducted in the garden and via mass media to demonstrate science-based, sustainable practices. The goal of the project is to have the most diverse collection of fruit trees/bushes/berries in the state. Bismarck population: 64,751* See appendix D.

4. The Local Foods Conference has been held for the past several years bringing together people from across the state interested in going local. By bringing our partners together with the local growers we will have the opportunity to shape the future of local foods movement while keeping organizations up to date with what is happening across the state and region. The target for 2012 was 175 conference attendees. Local food registrations will document this. In addition to the number of registrations, we will document a partner meeting during this conference. See Appendix E.

   The success and knowledge gained at the Local Foods Conference will be measured through a specialty crop survey. The survey will be administered to participants before the conference and again at the conclusion. The intellectual capital gained will be reported in the form of an impact report written by the NDDA. The goal is to have attendees take the specialty crop knowledge gained at the conference back to rural communities to increase existing community efforts in specialty crop awareness and consumption.

   a. The 2012 Local Foods Conference was a success with over 160 participants from across the state. This is a 20% increase from the 2011 conference. The event was held in Fargo, ND and we had a nice section of participants and presenters including discussion on building rural communities, equipment for small fruit and vegetable production and orchards, to list a few.
   b. Partner meetings were held during the meeting including discussion on the Hunger Garden Project, and planning with FARRMS and NDFMGA. This was a great opportunity to connect with folks across the state and region.

5. Promote and create awareness for local foods through our social media opportunities.
   a. North Dakota Local Foods is very active in social media. We are spreading the word about local foods through tweets, blogs and Facebook posts. The local foods marketing specialist has received numerous social media training sessions and has become a valuable source for growers and market vendors interested in social media outreach. See number 6 below for more information.
   b. The local foods movement saw social media traffic during our local foods conference in February. We brought five local bloggers to the conference to blog about their experience learning and visiting with farmers and growers from across the region. See one of the blog posts below along with a link to coverage from the event.
      i. http://accidentalpumpkin.wordpress.com/tag/dakota-grown-local-foods-conference-2012/
      ii. http://www.wday.com/event/article/id/58600/publisher_ID/29/

6. In October 2010, the Department of Agriculture started a Facebook fan page in order to attract new people to the concept of going local. During a few short months, the site has gained over 325 fans and continues to connect "going local" to our fans. This social media site will continue to reach out, educate and connect local food growers to consumers. The target for the upcoming year is to reach a fan base of 600 people.
   a. The Facebook page has become an important part of connecting with the local foods movement. Farmers market managers, shoppers and those looking for local foods

utilize our Facebook site to help stay connected. Currently we have 1,020 fans on our Facebook site and they have proven to be an active group.

Beneficiaries

The beneficiaries for the local foods initiative includes has reached people not only in our state but states surrounding. The focus of this grant was to reach out to school systems, farmers, small businesses, community organizations, under-privileged communities, and citizens. Approximately 120 schools, 45,142 students, 150 farmers and small businesses, 87 community organizations, over 63,602 under-privileged individuals, and around 214,000 citizens from across the region have been reached through this grant.

Lessons Learned

At the 2012 Local Foods Conference it was overlooked to do a specialty crops survey with those in attendance. That project was moved to the 2013 conference. At the conference random people were surveyed before the conference and when asked the question "Please rate you knowledge of specialty crops on a scale of 1 to 5, 5 being very knowledgeable. The average score was a 3. At the end of the conference random people were again asked the same set of questions and the average answer to the specialty crop knowledge question average was 3.87. See Appendix F for a list of questions and recap of the survey.

Contact

Jamie Good
Local Foods Marketing Specialist
North Dakota Department of Agriculture
600 East Boulevard Ave., Dept. 602
Bismarck, ND 58505

Additional Information

Appendix A (Hunger Garden Project)

Appendix B (Farmers Market Day at the Capitol)

Appendix C – Mobile Food Processing Unit

Appendix D – Orchard Grants

Pictures taken at the Dragonfly Garden

Appendix E – Local Foods Conference

Schedule of Events

Friday, February 3, 2012

7:30 - 8:30 a.m. Registration
8:30 a.m. Welcome & introductions
9:15 - 10:30 a.m. Keynote speaker - Christy James, Christy James & Associates, St. Paul, MN, is an information broker who specializes in facilitating strategic partnerships & collaborations by connecting organizations.
10:30 - 10:45 a.m. Break

SESSION	PRODUCTION	MARKETING
10:45 - 11:45 a.m.	Northern hardy fruits evaluation project - *Kathy Wieder-holt, Fruit Project Manager - Carrington*	AgriTourism - *Dean Ihla, Tourism Devel-opment Manager-ND Tourism Division*
11:45 a.m. - 1 p.m.	**Lunch with Noreen Thomas-What part of the puzzle do you fit?**	
1:00 - 2:15 p.m.	The Dragonfly Garden. Discovering new technologies - *Tom Kalb, NDSU Extension Horticulture Specialist*	Christy James - Continued
2:15 - 2:30 p.m.	break	
2:30 - 3:30 p.m.	Irrigation methods for small operations - *Dr. Thomas Scherer, NDSU Dept. of Ag & Biosystems Engineering*	Great Plains Food Bank - Hunger in the Heartland - Fresh produce donations
3:30 - 3:45 p.m.	break	
3:45 - 4:45 p.m.	Small equipment options, *John Hendrickson, University of WI-Madison*	Farm to School in ND - *Sue Balcom, FARRMS*

5:15 - 6:15 p.m. ND Farmers Market & Growers Association Annual Meeting - Everyone welcome
6:15 - 6:45 p.m. Social
6:45 p.m. Dinner and special presentation from Brian & Angie McCormick, Riverbound Farm CSA

Saturday, February 4, 2012

7:30 - 8:50 a.m. NDFMGA Board Meeting
7:30 - 9:00 a.m. Breakfast & open space discussions facilitated by Christy James
9:00 - 9:30 a.m. A word from NDFMGA President, Marvin Baker & NDFMGA Director, Holly Manby
9:30 -10:45 a.m. **Social Media and You - Why and how to engage your audience** - *Katie Pinke, NDDA*
10:45 - 11:00 a.m. Break

SESSION	PRODUCTION	MARKETING
11:00 - Noon	Economics of running a small farm - *John Hendrickson, U. of WI-Madison*	Tools to engage your audience - *Katie Pinke, NDDA*
Noon - 1:30 p.m.	**Lunch with Abby Gold, NDSU Nutrition & Wellness Specialist - ND "Works" the Food System**	
1:30 - 2:30 p.m.	Technical panel for meat & poultry - *Dr. Grandahl, NDDA*	Direct farm marketing - *Annie Carlson, FARRMS*
2:15 - 2:30 p.m.	break	
2:45 - 4:00 p.m.	Plant diseases - *Karen Ketner, NDSU Ext. Plant Diagnostic Lab*	Farmers market panel featuring market managers: *Susan Albertson, Lakeland; Anne West, Bowdon; Maria Effertz Hanson, Velva NPFM; Pam Anderson, Bismarck Capital; Rene Baker, Minot NPFM*

4:00 - 4:30 p.m. Conference wrap-up

Register Today

Local Food Conference - Feb. 3-4
Holiday Inn, Fargo

Name: _____

Address: _____

City, State, Zip: _____

Email: _____

Phone: _____

I'm registering a friend, or two:

Name: _____

Name: _____

Meals are included in the registration price; for planning purposes we will be attending:

Friday lunch: No.____
Friday evening banquet: No.____
Saturday breakfast: No.____
Saturday lunch: No.____

Please note any special considerations for you or a member of your party.

REGISTRATION $40 x ____ persons = _____

Enclosed is my check for $ _____

Checks should be payable to NDFMGA.

Registrations should be mailed before January 30th to:
NDDA, 600 East Boulevard Ave. Dept. 602
Bismarck, ND 58505 or email to: pritchet@nd.gov

Conference Agenda

Friday, February 3, 2012

7:30—8:30 a.m.	**Registration**
8:30 a.m.	**Welcome to Attendees**—*Marvin Baker, NDFMGA President, NDFMGA Director, Holly Mawby & North Dakota Department of Agriculture Staff*
9:15 a.m.	**Who will determine the future of *Your* community?** *Keynote from Christy James, Christy James & Associates*

Choose your session:	Production Session *Executive/Board Room*	Marketing Session *Director's/Conference Room*
10:45-11:45 a..m.	**Northern hardy fruits evaluation project** *Kathy Wiederholt, NDSU-Carrington Research Extension Center*	**AgriTourism—Turning farms, ranches and gardens into great destinations!** *Dean Ihla, ND Dept. of Commerce-Tourism Division*
Lunch 11:45 a.m.-1:30 p.m. *Royale/Embassy Room*	**North Dakota "Works" the Food System**—*presented by Abby Gold, NDSU Nutrition and Wellness Specialist/Assistant Professor* **Updates from the North Dakota Department of Agriculture** –*presented by Katie Pinkie, Communications Director w/ guest Keith Groven, Black Gold Potatoes*	
1:30-2:30 p.m.	**The Dragonfly Garden: Discovering new technologies** *Tom Kalb, NDSU Extension Horticulture Specialist*	**Identifying community assets** *Christy James, Christy James & Associates*
2:45-3:45 p.m.	**Irrigation methods for small operations** *Dr. Thomas Scherer, NDSU Department of Agriculture & Biosystems Engineering*	**Hunger Free North Dakota Garden Project and the Great Plains Food Bank Hunger make connections through produce donations** *Linda Sailer, Director of Product Resources, Great Plains Food Bank & Dana Pritschet, NDDA*
3:45-4:00 p.m.	Break & Networking—*Royale/Embassy Room*	
4:00-5:00 p.m.	**Equipment options for small scale vegetable production** *John Hendrickson, Senior Outreach Specialist, University of WI-Madison/Farmer*	**Scaling up local foods with Farm to School** *Sue Balcom, ND State Farm to School Lead, FARRMS*
5:15-6:15 p.m.	**ND Farmers Market & Growers Association Annual Meeting** *Press Room*	**Listening session on USDA Specialty Crop Block Grants** *MEZZ IV Room*
6:15 p.m.	**Social**	
6:45 p.m. *Royale/Embassy Room*	**Dinner and a special presentation from Riverbound Farm.** *Angie and Brian McGinness are a farming couple in their 5th season of full-time farming. Together they operate Riverbound Farm, an organic vegetable CSA serving the Bismarck-Mandan community.*	

Conference Agenda

Saturday, February 4, 2012

7:30-8:30 a.m.	**NDFMGA Board Meeting** –*Press room*
7:30-9:00 a.m.	Hot breakfast w/ **round table discussions** facilitated by Christy James *Royale & Embassy*
9:00 a.m.	**Welcome to attendees** - NDFMGA President, Marvin Baker
	A word from Agriculture Commissioner, Doug Goehring
9:30-10:45 a.m.	**Social media and you—Why and how to engage your audience**
	Katie Pinke, North Dakota Department of Agriculture Marketing & Information Director

Choose your session:	Production Session *Executive/Board Room*	Marketing Session *Director's/Conference Room*
11:00 a.m.- Noon	**Economics of running a small vegetable farm** *John Hendrickson, Senior Outreach Specialist, University of WI-Madison/Farmer*	**Tools to engage your audience** *Katie Pinke, North Dakota Department of Agriculture Marketing & Information Director*
Lunch - Noon *Royale & Embassy*	**What part of the puzzle do you fit?** *A puzzling matter? What piece of the local foods puzzle fits you? Noreen Thomas*	
1:30-2:30 p.m.	**Technical panel for meat & poultry** *Panelists include Dr. Andrea Grondahl, ND State Meat Inspection Director; David Knudsvig, Two Guys' Meat and Noreen Thomas, local producer*	**Direct farm marketing** *Annie Carlson, FARRMS Executive Director*
2:30-2:45 p.m.	Break & Networking	
2:45-4:00 p.m.	**Recognizing and managing vegetable diseases** *Kasia Kinzer, NDSU Plant Diagnostician*	**Farmers market panel featuring outstanding market managers:** *Sonya Albertson, LaMoure; Anne West, Bowdon; Maria Effertz-Hanson, Velva NPFM; Pam Anderson, Bismarck Capital; and Ilene Baker, Minot NPFM*
4:00-4:30 p.m.	*Conference wrap-up –final announcements, evaluations, and make connections for the upcoming year!*	

Thank you to our sponsors :

North Dakota Farmers Market & Growers Association

North Dakota Department of Agriculture

Nodak Mutual Insurance Company

Sysco North Dakota, Inc.

Entrepreneurial Center for Horticulture

USDA Specialty Crop Block Grant

A special thank you to our live bloggers for being a part of the Local Foods Conference:

Pam of It's Time For More Coffee
Val of Wag'n Tales
Sarah "Farmer on a Mission" of J.S. Wilson Farm
Kirsti of GriggsDakota
Beth of Rhubarb and Venison
Brenda of I Need Chocolate
Laura of The Accidental Pumpkin

We hope you enjoyed the conference!

3

Appendix F – Specialty Crop Survey

Question*- All questions are on a scale of 1-5. 1 being little knowledgeable, 5 being very knowledgeable.	Pre-Survey Average	Post Survey Average
Please rate your knowledge of specialty crops.	3.0	3.87
Please rate your knowledge of getting your specialty crops to stores, schools, restaurants, etc.	2.0	3.39
Please rate your knowledge of creating a successful specialty crop variety trial.	2.0	3.14
Please rate your knowledge on the safety rules and regulations for specialty crops.	2.13	3.39
Please rate you knowledge of what is going on and what you can do with specialty crops in North Dakota.	2.5	3.68

*The questions are from topics from the 2013 Conference. There is a strong correlation that the conference did increase attendees' knowledge of topics surrounding specialty crops.