Final Report

North Dakota Specialty Crop Grant
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North Dakota Reference # 01910
$118,582.30
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Final Reports:

Project A Northern Plains Potato Growers
Project B Northarvest Bean Association
Project C Minot State University- Bottineau Center for Horticulture
Project D Northern Pulse Growers Association
Project E North Dakota Nursery & Greenhouse Association
Project F North Dakota Grape Growers Association

Project A Northern Plains Potato Growers Association
Final Report

Title: Maximizing Profits through improved grower education

Summary of Activities

The purpose of this project is to better position the potato industry in Minnesota and North Dakota to maximize profits for potato growers through improved grower education programs involving the Area Extension Agronomist focusing on improved cultural practices, support for our breeding program activity and the continuation of our market initiative. This grant has allowed us to continue to build upon the results we have accomplished through a previous Specialty Crop Block Grant.

Project Approach

Our approach to this Specialty Crop Block Grant was to work through Dr. Nick David, NDSU/UMN Extension Agronomist for Potatoes, to improve cultural practices and accelerate new variety releases through increased and improved support to the breeding programs and disseminate that information to growers. Dr. David was responsible for coordinating all research with North Dakota State University (NDSU), University of Minnesota (UMN) and Untied States Department of Agriculture-Agricultural Research Service (ARS). He was responsible for all aspects of the research from soil preparation through storage testing, sharing the information with growers and variety release. Through this method one individual would be involved hands-on from start to finish.

Our approach to the marketing and advertising side of the equation was a continuation and enhancement of our fresh market program, designed to improve demand and grower returns.

Performance Goals and Progress

1. **Maintain the strength of our fresh marketing and advertising campaign.**
   - Continued cooperative effort focused on conferencing, together with inventory, pricing and demand aspects of the market.
   - Provide potato dish samples, frozen product samples and potato chip samples at various food and trade shows.
   - Our advertising campaign is matched by our fresh shippers on a pay to participate basis which improves our market exposure. (see attached documents)
   - Continue to upgrade our display booth and trade show equipment. (see attached documents)
   - Continue to place strategically integrated advertisements into sectional editorials of various produce publications. (see attached documents)
   - We have developed two videos which will be an important part of our trade show display and intend to use them as a web stream on our updated website which was designed by Anchor Marketing. A link to our updated website is http://www.nppga.org/

   - Attended national food shows which focus on both foodservice and fresh market promotion. (See attached documents)

May 2009:
Exhibit at National Restaurant Show, Chicago, IL

July 2009:
Exhibit at North Dakota State Fair, Bismarck, ND

August, 2009:
Exhibit at Russ Davis Food Show, Wadena, MN
Exhibit at Northern Plains Potato Growers Field Day, Hoople & Inkster, ND
Exhibit at Schnuck's Fresh Expo 2009, St. Louis, MO

October 2009:
Exhibit at Produce Marketing Association Convention, Anaheim, CA
Exhibit at North Dakota Winter Shows, Valley City, ND

January 2010:
Exhibit at 2010 Potato Expo Convention, Orlando, FL
Exhibit at Washington-Oregon Potato Conference, Kennewick, WA

February 2010:
Exhibit at International Crop Expo, Grand Forks, ND

May 2010:
Will Exhibit at National Restaurant Show, Chicago, IL

2. Improve cultural practices and expand the number of varieties released from our potato breeding programs as well as disseminate this information to growers.

- Continue to expand the number of varieties released from potato breeding programs in cooperation with North Dakota State University and University of Minnesota. We have increased several red, white and russet varieties.
- The Northern Plains Potato Growers Association has made the decision to move our irrigated research from Tappen, ND to the Forest River Colony near Inkster, ND. Our Tappen research site is a very long commute from the universities and the costs were beginning to outweigh the advantages of a near perfect site for irrigated research. The research community also felt they were not accomplishing proper management of the plots due to the distance of travel, time and expense allocated to that travel. We agreed that moving our irrigated site closer to other research sites near Grand Forks, Larimore, Hoople and Park River was in our best interests. The site is also over twice as large as our Tappen site and will give us the ability to increase our rotation substantially.

- We are doing potato research at twenty-two different research sites in North Dakota and Minnesota. In North Dakota we have sites at Williston, Langdon, Grafton, Crystal, Hoople, Inkster, Grand Forks, Larimore, Absaraka, Prosper, Dawson, Pettibone, Oakes and Wyndmere. In Minnesota we have sites at Crookston, East Grand Forks, Osage, Park Rapids, Glyndon, Rice, Becker and Rosemount.

- Our research community planted research plots, fertilized, irrigated, sprayed and cared for these research plots this past spring and summer. The harvest was completed last fall and the tubers were stored at the USDA/ARS Research Lab in East Grand Forks, MN. Post harvest research has been conducted on thousands of tuber varieties through storage at various temperatures, time intervals and humidity levels. The tubers are then fried as French fries or chipped, if a chipping variety, to determine color, texture and taste characteristics.
- The highlight of 2009 was the release of AOND95249-1Russ as Dakota TrailBlazer, in December. It offers producers and processors sugar end, *Verticillium* wilt, pink rot, and late blight (field) resistance, in addition to outstanding French fry/frozen processing and table stock properties. Dakota TrailBlazer has very high specific gravity, long dormancy, and cold sweetening resistance, processing reliably from 42F storage. The most promising selections in our North Dakota program include red table stock selections, ND4659-5R and ND8555-8R. Dual-purpose russet selections, ND8229-3, AOND95292-3Russ, and ND8068-5Russ possess excellent appearance and processing qualities. ND7519-1 and ND8304-2 possess superior chip processing traits.
- The University of Minnesota potato breeding research is emphasizing the development, evaluation, and distribution of potato cultivars and germplasm with improved yield, quality, and disease resistance by developing new hybrid progenies and evaluating them in multiple dry land and irrigated locations. Post harvest storage and quality characterizations are performed from 40, 42, 45, and 48F throughout the 7 month storage season; focusing on sugar end and cold induced sweetening. The most advanced selections will be evaluated for Nitrogen use efficiency, N timing and spacing. Novel breeding methods and germplasm enhancement strategies are pursued to increase the efficiency of determining disease and pest resistance characterization early in the breeding effort. A focus is on foliar and tuber late blight, common scab, potato virus y (PVY) and potato leaf roll virus (PLRV) symptom expression, common scab, Colorado potato beetle (CPB), aphids, Verticillium wilt, and sugar end and cold induced sweetening.

Lines developed that require immediate attention to determine commercial marketability

Processing
AOMN 03178-2 – This is a blocky russet, white flesh FF processing clone. This clone rated high in Simplot fry tests conducted at the USDA lab.
MN 02419 – This long white flesh FF processing clone rated high in Simplot fry tests conducted at the USDA lab.
MN 18710 – This is a shallow eye russet skin white flesh selection having very attractive tubers for fresh market.

Red
ATMN 03503-3 – This red skin cream flesh selection has excellent color and yields similar to Red Norland.
COMN 03020-3 – This red skin white flesh selection has excellent color.

COMN 03021-1 – This red skin cream flesh selection has excellent red color medium in size.
COMN 03019-4 – This red skin cream flesh selection has excellent red color.
MN 02616 – This red skin yellow flesh selection has excellent red color and very attractive uniform flesh color.
MN 96013-1 – This red skin yellow flesh selection has excellent red color and very attractive flesh color.
MN 96072-4 – This red skin yellow flesh selection has excellent red color and uniform attractive yellow flesh.

Chipping
MN 99380-1 – This round white yellow flesh selection yields attractive golden colored chips from 45F into the storage season. It has 2x been entered into the Snack Food Association trials (SFA), most recently by Dr. Nick David and continues to demonstrate its low accumulation of reducing sugars.
MN 02696 – This round white selection with white flesh was determined to chip acceptable directly from 40F.
MN 02586 (W/ Lt Y flesh), MN 02588 (W/ W flesh), MN 02589 (W/ W flesh), and MN 02703 (W/W flesh) selections have been identified by J. Sowokinos and USDA as having acceptable chipping quality from 42-45F storage.

- All potato research assists us with solving production problems, creating cost saving avenues for growers as well as addressing environmental concerns.
- Dr. Nick David's research projects deal with varietal development, ground water and nitrogen, crop rotation and irrigation studies that will help growers become more environmentally conscious.
- Dr. Nick David administered a one day research reporting conference as well as two, one-half day educational seminars at the International Crop Expo this past February. It allows researchers to provide growers a summary of all projects performed for the past year and includes speakers from across the country to address potato related issues.
- Purchased a colorimeter for Dr. Nick David to use in the processing phase of his research. This will allow Dr. David to determine french fry, chipping and red potato color characteristics before, during and after the processing stage which will be an early indicator of whether we should continue selecting these clones for further study.
- Dr. David also organized Potato Field Day on August 20, 2009. Growers were able to visit our Larimore, ND site, our Inkster, ND site and Oberg Farms for plot tours and presentations by researchers from UMN, NDSU and USDA/ARS East Grand Forks, MN site. The day was very complete, starting at 7:30 AM and concluding at 9:00 PM.
- Please review attachments for documentation of several of these initiatives.

Project Developments
We were unable to purchase a GPS backpack system for our potato plot work. We ordered one but found several deficiencies with software and signal and returned it. We do intend to purchase a GPS backpack or portable system in the future but will need to do more research to find one that works well and suits our needs.

We did have unanticipated research expenses which were projects that required our immediate attention and would like to request that the intended funding of $9800 for the GPS backpack be used instead to help fund two additional priority research projects that became an instrumental part of our overall focus. These two projects were basically an expansion of the work we were already doing with the Specialty Crop Block Grant funding and did not change the scope of our proposal. Both projects tied specifically into our project approach of working through Dr. Nick David to improve cultural practices and accelerate new variety releases through increased and improved support to the breeding programs.

These two research studies have been integral in studying potato clones for Verticillium Wilt resistance as well as determining fry and chip characteristics of potatoes stored at various temperatures and intervals. By funding these two projects we were able to select potential varieties for resistance to Verticillium dahliae and cold sweetening resistance prior to taking the clones to the next level. Without these two studies we would not have been able to release Dakota Trailblazer, our new NDSU variety, which is resistant to Verticillium Wilt and can process at temperatures of 42 degrees. Both projects enhanced the work already being done for our 2008 Specialty Crop Block Grant. These two studies were instrumental in helping us achieve our goals of expanding the number of varieties released from our breeding program and assist in the screening for both markers of cold induced sweetening (CIS) resistance as well as assisting in the screening of breeding selections from breeding programs for market potential from storage at different temperatures and intervals.

The first project funded by the NPPGA through the University of Minnesota was the continuation of University of Minnesota research on cold sweetening and invertase screening at the USDA Potato Research Worksite in East Grand Forks, MN. Dr. Joe Sowokinos retired from the staff of the University of Minnesota and funding of $32,215 was provided to hire a qualified laboratory person, Dr. Sonu Kashyup, on site to assist in the screening for both markers of cold induced sweetening (CIS) resistance as well as assisting in the screening of breeding selections from US breeding programs for market potential from storage at different temperatures and intervals. This work involved a joint effort linking personnel and resources of NDSU, the USDA/ARS Potato Research Laboratory in East Grand Forks, MN and the University of Minnesota.

A cold sweetening resistant (CSR) potato would retain its raw product quality due to (a) decreased microbial spoilage i.e., reduced need for the application of fungicides and bactericides, (b) reduced shrinkage, (c) retention of dry matter, and (d) delayed sprouting and physiological aging. These benefits would increase the environmental friendliness, the marketing window, sustainability, and profits of potatoes grown for processing markets. Categorizing advanced potato breeding clones for anti-sweetening potential aids the potato breeder in selecting the best possible genotypes for future matings as well as to aid in the identification of „new upcoming' cultivars with superior storage and processing potential.

(1) Project A: Work Results and Future Plans:
Seventy-two and twenty-four distinct genotypes of AOND95292-3 and ND7882b-7, respectively, were generated as minitubers during the fall and winter of 2006. Field planting in 2007 was for the purpose of increasing tuber number. In the spring of 2008, each genotype was

planted in ten hill plots at Wyndmere, ND. Tubers were harvested in mid-September and placed into 6°C storage. Random russeted intragenic (ITG) lines were analyzed for the presence of the *Ugp*A gene and the anti-sweetening protein (UGPase-UGP5). Using native-activity gels, the anti-sweetening protein was evident and was highly expressed. A total of sixty lines were selected (based on yield performance) and planted in replicated field trials at Inkster, ND, in the spring of 2009. A replicated transient water stress trial was also conducted to determine any resistance to the development of sugar-ends. All tubers were harvested September 26 and samples were divided between North Dakota State University, Fargo, ND (i.e., evaluation for yield, French fry color and storage performance) and the USDA Potato Research Worksite in East Grand Forks, MN (evaluation for specific gravity, sugars, fry color, and AcInv activity, both at harvest and following three month storage at 6°C). Native activity gels were conducted on each genotype to ensure the presence of the anti-sweetening gene and its expressed protein. Several improved genotypes emerged that demonstrate superior yield, specific gravity, fry color, and storage performance compared to their untransformed controls. Future plans: A second-year study with replicated field trials at Inkster, ND in the spring of 2010. Following research data obtained in 2011, the top performing lines will be placed into tissue culture for the eradication of viruses. It is anticipated that minitubers will be available for grower field-testing in either the spring of 2012 or 2013.

(2) Project B: Work Results and Future Plans:
In 2004, sixty-four intragenic (ITG) genotypes of Dakota Pearl were transformed with the anti-sweetening gene from the chipping cultivar Snowden. Over the past five years, potatoes were selected for canopy cover, vigor, flowering, and maturity during the growing season and for yield, tuber number, size distribution, and chip color at harvest. Each year ITG lines were evaluated from storage for sugars, AcInv activity, and chip color following storage at 38° F, 40° F, and 42° F. Tubers from the 2009-2010 growing and storage season were evaluated for the parameters described above. Future plans: Dr. Kashyap will place the top five performers into tissue culture this fall for the eradication of viruses. It is anticipated that new genotypes of Dakota Pearl will be available for grower field evaluation in 2011 that are superior in storage and chipping performance compared to the untransformed control.

(3) Project C: Work Results and Future Plans:
Past research has shown that potatoes with low AcInv accompanied with the A-II anti-sweetening isozymes of UGPase accumulated less reducing sugars in storage. Currently, 106 advanced breeding clones are being screened for anti-sweetening potential i.e., good color from storage along with low AcInv activity and the presence of the anti-sweetening protein, A-II. This screening can accelerate the selection of superior storage and processing potatoes as well as aid in the selection of parental material to be used in future matings. Dr. Kashyap assists Martin Glynn, USDA/ARS Worksite Coordinator in East Grand Forks, MN, in completing this project. Results of this study are presently being compiled and will be reported in the *Valley Potato Grower* and well as the *Amer. J. of Potato Research.*

Dr. Nick David helped oversee much of the work being done at the USDA Research Site. Dr. David also administered a Research Reporting Conference and seminars, which gave Dr. Sowokinos, Dr. Kashyap and Matin Glynn the ability to share this research with potato producers.

The second project funded by the NPPGA, was through Dr. Asunta Thompson and Dr. Neil Gudmestad and North Dakota State University. The project titled "An Accelerated Breeding Program for Verticillium Wilt Resistance in French Fry Processing Cultivars" will accelerate efforts to breed potato cultivars that are highly resistant to Verticillium wilt. Approximately 34 million pounds of the active ingredient metam sodium are applied by the potato industry each year for the control of Verticillium wilt at a cost of nearly $170,000,000, not including the application. Metam sodium is currently under re-registration by the Environmental Protection Agency (EPA) and although its fate is unknown, it is clear that there will be restrictions placed on its use. Potato cultivars that resist Verticillium dahliae would be economically and environmentally a more favorable means to control early dying. We are funding this research at a level of $42,840.

The NDSU potato breeding program currently makes 2,500 to 3,200 crosses each year, resulting in 350 to 730 new families. Approximately 80,000 to 100,000 seedlings representing these families are evaluated annually in the field. To date, approximately 22% of the crosses are directed at improving the quality of French fry processing in potato cultivars. Although advanced clones are often evaluated for their susceptibility to *Verticillium* wilt, currently there is no directed effort to breed potato cultivars possessing durable host-plant resistance to *Verticillium* wilt. Nonetheless, an advanced potato clone AOND95249-1Russ has recently been determined to have high levels of *Verticillium* wilt resistance. This advanced clone also has excellent French fry processing qualities.

This research established a *Verticillium* wilt resistance breeding program for potato and accelerated efforts to incorporate resistance to *V. dahliae* into genotypes that possess superior processing qualities. The goals accomplished through this accelerated potato breeding program for *Verticillium* wilt resistance in potato included the following:

(1) Evaluate all current French fry processing cultivars and advanced clones for their response to *V. dahliae*. These evaluations will quantify the potato/pathogen response using previously established methods.
(2) Make an additional 750 crosses with advanced potato clones and potato cultivars with known resistance to *Verticillium* wilt. These crosses will be made with clones with known French fry processing quality.
(3) Identify new sources of resistance to *V. dahliae* using greenhouse and laboratory methods that quantify the pathogen in each potato clone.
(4) Establish a field plot infested with *V. dahliae* that will be used annually to evaluate potato clones for resistance to *Verticillium* wilt under irrigated potato conditions prevalent in the Midwestern USA.
(5) Quantify the potato/*V. dahliae* interaction by determining levels of the pathogen present in each potato clone. This will ensure that the reaction of the potato clone is one of resistance and not tolerance.
(6) Develop a real-time PCR method that will quantify the potato/*V. dahliae* response and compare it to published laboratory methods. This will make future evaluations of potato clones and their response to *V. dahliae* more rapid, less labor intensive and less costly in the future.

Dr. Nick David helped oversee much of the work being done at NDSU and the USDA Research Site. Dr. David also administered a Research Reporting Conference and seminars, which gave Dr. Thompson and Dr. Gudmestad the ability to share this research with potato producers.

We hope you will see the value and the necessity of these two research studies to our overall Specialty Crop Block Grant project, which was to accelerate new variety releases through increased and improved support to the breeding programs and allow us to use the $9800 to help fund a portion of these two projects.

We are also working in conjunction with the Agriculture Utilization Research Institute (AURI), the Economic Development Housing Authority (EDHA) of East Grand Forks, MN, the Mahnomen Baked Chips Company of Mahnomen, MN and potato washplants, processors and growers on the possibility of pursuing a potato flake processing facility in the region. Since the closure of the R.D. Offutt potato flake facility there has been a market created for flakes. We have four baked chip plants in the area that are currently contracting for product from out of state. There are large supplies of "cull" potatoes available that could be used to process flakes which would accomplish removing unmarketable potatoes at no cost to the producer and producing a flake product that could be sold and utilized. There is also discussion of using waste product from a flake facility to feed a digester to produce energy. We are also now proposing doing a feasibility study to look at a potato vodka manufacturing plant. The construction and operation of a facility would be very feasible, but we must look at the marketing side of the equation. The Agriculture Utilization Research Institute and the Dashiell Group, Inc. have agreed to help us prepare a feasibility study.

Results, Conclusions, and Lessons learned

Breeders now have several varieties which need to be increased to improve seed availability as well as develop cultural practices to improve their productive capabilities. Currently breeders have several varieties that would work in the process/frozen industry and need to be produced and processed to prove their characteristics work in today's competitive market. Varietal development is an extensive process requiring several years but the work must continue in order to benefit the industry in the future. Potato varieties are a large portion of the answer to disease, insects, weather, storage and the ability to process to the requirements of the industry.

Beneficiaries

Three hundred fifty potato growers from Minnesota and North Dakota have benefited from this Specialty Crop Block Grant. Fresh potato grower returns have stayed level with last year, which should be considered a success considering there was over-production across the United States and many of the other major potato producing areas sold potatoes at one-half of the previous year's value. Process potato growers have increased potato contracts by 30%, through improved negotiating, which will yield an additional $23,000,000. Research carries a regional economic development value of over $1,000,000. This value is created simply by funding the research. The value to farmers carries a value in millions of dollars annually as we solve production problems, create cost saving avenues for producers and introduce new varieties into the consumer market.

Long Term Outcome Measures from these projects
As a result of our research efforts, breeders have enough material to make 2 or 3 releases in each of the next 4- 5 years.

Our marketing program has been updated and improved thanks to this grant and a previous Specialty Crop Block Grant. We are now able to promote and advertise our product with new equipment and materials and will build on our program again next year.

Contracts were entered into with North Dakota State University and the University of Minnesota to continue support for a new extension agronomist for potatoes, resulting in a positive impact for the potato industry.

The projects conducted with the assistance of the United States Department of Agriculture Specialty Crop Program have helped the continued forward movement in varietal development, initiated positive direction in improving cultural practices and have improved market prices for both the fresh and process potato segments within our industry.

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Project B Northarvest Bean Growers Association
Final Report

Outline of the Issue/Need for Projects
To enable the Northarvest Bean Growers Association (NBGA) to develop a scalable, sustainable, and measurably effective program of electronic-based health communication targeting dietary professionals in their roles as "health influentials." The goal of this program, broadly stated, is to increase awareness of the health benefits of dry beans among select groups of dietary professionals resulting in an increase in recommended levels of use of beans in healthy diets among consumers they reach.

Projects to be undertaken to address the Issue

Project 1: Development and launch of a new health related website for dry beans

Project 2: Establish editorial newsletter board

Project 3: Electronic newsletter to dietitians

Project 1: Development and launch of a new health related website for dry beans

Project Summary
The Northarvest Bean Growers Association has, over the preceding decade, advanced a number of initiatives to increase awareness of the dietary benefits of dry bean use. The level of investment and expertise required to sustain mass-market programs has proven problematic, and has contributed to a more focused and cost-effective strategy described here.

Project Approach
Northarvest had ongoing discussions with Dr. Bill Lesch, chairman of UND Marketing Department regarding the model, process, outcomes, and cost associated with web development, assembling and distribution of electronic newsletter. It must be noted from the outset that it takes a team of talented individuals to plan and implement a project with so many "legs," since the talents and materials required are not within the span of control of any single individual.

Project Goals Achieved
Competitor website review and analysis was undertaken and concluded by;
RESEARCH AND PRODUCTION-UND
Dr. Mary Askim-Lovseth, Survey Research and Production
Ms. Rachel Lundbohm, Production Manager and Contractor Liaison
Ms. Corrine Iverson, Production and Traffic Coordinator
Mr. David Konerza, Research Design and Editorial Review
Mr. Kevin Williams, Research

Beneficiaries
To increase awareness of the health benefits of dry beans among select groups of dietary professionals resulting in an increase in recommended levels of use of beans in healthy diets among consumers.

Results, Conclusions and Lessons Learned
February 2010 UND launched the fully operational and trade marked Bean Institute web site. The web address for The Bean Institute is www.beaninstitute.com. Working with a team of professionals under the supervision of the UND Marketing Department chair instilled confidence in our approach to developing the health web site. UND also aided the trade marking of the name; Bean Institute. Following launch Northarvest needed to enhance and promote the site. Communiqué Inc of Jefferson City Missouri added a search function, overhauled and worked on technical issues with Farm to Fork, added registered dietician educational power point presentation titled Beans 101, added new section called "Latest Research" and promoted the site by email to some 36,000 registered dieticians. Monitoring the web activity showed we were beginning to get some traction by June and hits on the website have come from nearly a dozen countries around the world.

Project 2: Establish editorial newsletter board

Project Summary
UND to assemble editorial newsletter board for Northarvest to support development of an electronic newsletter to dieticians touting health benefits

Project Approach
Earlier Northarvest produced a comprehensive beans and health literature review and hosted a gathering of some 30 scientist to further tout health benefits and beans. This became our pool of candidates.

Project Goals Achieved
UND was able to pool, screen and obtain the services of four individuals to produced copy and design layout for a Dry Bean Health Newsletter
EDITORIAL BOARD
Ms. Amy Myrdal-Miller, Culinary Institute of America
Dr. Julianne Curran, Product Innovation Manger, Pulse Canada
Dr. Cliff Hall, Associate Professor, North Dakota State University
Dr. Andrea Hutchins, Associate Professor, Colorado State University

Beneficiaries
Credible message, target audience and ultimately the consumer.

Results, Conclusions, and Lessons Learned
With the final selection of the two practicing researchers and two practicing dieticians that demonstrate the ability to write, be published and demonstrate a strong willingness to participate

to further tout the health benefits of beans is achieved with the above mentioned individuals. Some candidate showed an interest but these individuals demonstrated a commitment.

Project 3: Electronic newsletter to dietitians

Project Summary
The development and launch of an electronic newsletter to dietitians touting the health benefits of dry bean

Project Approach
Northarvest had knowledge of another commodity that successfully developed and distributed an electronic newsletter to the dietetic community. We followed their blue print minimizing any delays and cost over run.

Project Goals Achieved
Northarvest contracted with Steve Veile, COMMUNIQUÉ, Inc., Jefferson City, MO to begin work with our established editorial board to develop and launch an electronic newsletter to dietitians touting the health benefits of dry bean use. June 11 the first issue of Dry Bean Quarterly (DBQ) was distributed electronically and reviewed by 6,425 registered dieticians. DBQ is posted on www.beaninstitute.com.

Beneficiaries
Dieticians are delivered scientific evidence touting the health benefits of beans and in the position to educate the consumer. The consumer is in the position to make smart choices and increase demand for dry bean.

Results, Conclusions, and Lessons Learned
Communiqué consulted with editorial board about content, selected newsletter themes, contacted potential authors for articles, designed masthead, edited articles as they were submitted by authors, created email version of newsletter, created layout for print newsletter, received approval from editorial board to send email version. Communiqués publishes another health research newsletter (Soylink) and manages the soy web site. The experienced management of Communiqué helped Northarvest target the correct set of dieticians within the very diverse group of dieticians belonging to the American Dietetic Association.

Long-Term Outcome Measures
Northarvest will track (through its consultant Communiqué) the influence the health newsletter has on the dietetic community, track the number of dieticians that find the information useful and track the number of visitors to the Bean Institute web site.

Northarvest extends its deepest appreciation to the Commissioners and staff of the North Dakota and Minnesota Departments of Agriculture, and the United Stated Department of Agriculture for their efforts to advance this and related programs.

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Project C Minot State University
Bottineau Entrepreneurial Center for Horticulture
Final Report

Title: Producer Education Series for Organic and Specialty Vegetables

An outline of the issue, problem, interest, or need for each project.
o Consumer demand for locally grown food continues to drive media attention and wholesale purchases. Increased fuel and transportation costs necessitate that many distributors, logistics companies and local grocery and restaurant businesses must source more products closer to home. Consumers want to know more about where their food comes from, the methods of production and processing, and who grew the product. The number of North Dakota vegetable producers continues to increase as the number of outlets, such as farmers markets, continues to rise. These producers have the potential to become extremely important links in the food distribution chain if they receive training and preparation for the market and its guidelines. By delivering training to organic and specialty vegetable producers throughout the state, this program effectively prepared them for entry into the market.

How the issue or problem was approached via the project(s).
o The purpose of this grant was to research, develop and deliver organic and specialty vegetable training modules and related reference materials to producers across the state. The trainings were delivered via distance learning technology making them accessible to all parts of the state equally without the need for extensive travel by participants.

o Hand-outs, training aids, guides and recorded training sessions are housed in the Entrepreneurial Center for Horticulture (ECH) clearinghouse, accessible via internet, for future review by producers.

o The ECH utilizes a software program called „PersonalBrain Pro' from TheBrain Technologies to publish to its web site all reference material, hand outs, related articles, guidelines and producer schedules as well as streaming audio of the trainings. Founded in 1996, TheBrain Technologies is the leading provider of visual content management solutions and provides award-winning information management solutions with more than a decade of accomplishments. By connecting people, processes, and information, TheBrain's products provide unparalleled context for smarter information delivery and more informed decision-making. Internet users can utilize PersonalBrain technology without additional downloads or software. Having this online data available will better enable the producers of North Dakota to make informed decisions, find markets, and deliver fresh, nutritious foods to the consumers. Additionally, these producers can increase their markets thus increasing their profitability and long term viability. This project, in collaboration with Dakota College at Bottineau's Entrepreneurial Center for Horticulture (ECH), has the potential to position North Dakota as a national leader in the production, promotion, and distribution of organic and specialty vegetables.

How the goals of each project were achieved.
o Design of reference and training materials in 5 major areas of production and marketing of organic, locally grown and specialty vegetables. Training materials were designed and disseminated for each of the training sessions outlined below. Training materials included transcripts of training sessions, brochures and reference publications.

o Delivered 10 trainings via teleconference, and internet to allow for access statewide. Training topics and dates were as follows:

- *Prospecting Chefs and Restaurants*, hosted by Sarah Potter Aubrey, Prosperity Ag Resources, May 13th, 2009
- *Marketing at Your Farmer Market*, hosted by Sarah Potter Aubrey, Prosperity Ag Resources, May 20th, 2009
- *Wholesale Success*, hosted by Sarah Potter Aubrey, Prosperity Ag Resources, October 15th, 2009
- *Selling to Schools, Nursing Homes, Hospitals and other Institutions*, hosted by Sarah Potter Aubrey, Prosperity Ag Resources, October 22, 2009
- *Blog, Twitter and Book Your Way to Free Marketing*, hosted by Marlo Miller, TrainND, October 29, 2009
- *Food Safety From Field to Customer*, hosted by Sam Beattie, Food Safety Extension Specialist, Iowa State University, November 5, 2009
- *Farmers Market Food Safety*, hosted by Kenan Bullinger, ND Department of Health, Division of Food and Lodging, December 4th, 2009
- *Preparing for Sale – Packaging and Labeling Your Product*, hosted by Holly Mawby, Director of the Entrepreneurial Center for Horticulture, Dakota College at Bottineau, December 8, 2009
- *Be Sure about Insurance*, hosted by Dave Oehlke, ND Senator and Insurance Agent, December 11, 2009
- *Beginning a CSA*, hosted by Annie Carlson, Marketing Specialist and owner of Morning Joy CSA farm, December 16, 2009

o Implementation of an online clearinghouse of information related to locally grown produce production, marketing, policy and guides for use by producers statewide. The online clearinghouse, via TheBrain software went live online in November of 2009. The clearinghouse is arranged in topic areas including: production, marketing, online databases, online partner resources and upcoming events. The clearinghouse contains links to .pdf files from magazines and trade journals, training session recordings, webinars, online training programs, related web sites and publications regarding the vegetable production and direct marketing industry. All teleconference training sessions listed previously in this report were taped and are available for download through the clearinghouse. It also contains a search function to aid the user in identifying resources related to their area of interest.

o Participation by at least 60 producers (unduplicated head count) – in trainings.
The goal of 60 producers was not met with this grant. An unduplicated total of 14 producers and market managers participated in training sessions. Several participants took part in more than one session with a duplicated total of 25 participants.

o Distribution of 75 training and reference material packets to producers. The packets were distributed in February of 2010. Packets were mailed to a select list of producers throughout the state. Recipients were identified using ND Farmers Market and Growers Association membership lists, ND Producer Directory listings and referrals from other agencies. Within two days of mailing the Producer packets, the ECH received numerous calls asking for further information or resources. Several recipients expressed interest in and subsequently signed on for additional services and training through the ECH. The producer packets of information continue to be assembled and distributed. Recipients have expressed a high level of satisfaction with the resources and information provided in the packet. To date an additional 60 packets have been requested and subsequently mailed out to producers indicating a very high level of satisfaction with the information and training materials gathered as a result of this grant thus reaching the goal of educating or training over 75 producers.

• **Results, conclusions, and lessons learned for each project.**
At the completion of the tele-trainings, a survey instrument to measure satisfaction was designed and mailed to all participants. With an unduplicated head count of 14, there were few surveys to mail. Only 8 participants responded to the survey. However, their comments were extremely helpful in determining how to continue to provide information and services to producers across the state. Noontime tele-conferences seem to be preferred with a winter (January to April) time frame. To ensure the success of future trainings, more marketing of the program will be necessary. The survey results are below:

Question	Very Inconvenient	Inconvenient	Convenient	Very Convenient
How convenient was it for you to attend the conferences via telephone?			**2**	**6**
How convenient was the noon timeframe for participating in the teleconferences?		**1**	**2**	**4**
How convenient was the evening time frame for participating in the teleconferences	**2**	**1**	**1**	**1**
How convenient was it to receive the training materials via email? - *Disregard this question if you received them via regular mail.*		**1**		**5**
How easy was it to use the teleconference system? (1-800 dial in number and passcode system?)			**1**	**7**
	Very Dissatisfied	**Dissatisfied**	**Satisfied**	**Very Satisfied**
How satisfied were you with the information that was presented?			**3**	**5**
How satisfied were you with the customer service of the ECH staff?			**3**	**5**

How satisfied were you with the hand-outs, training materials (if available) for your tele-training? – *If none were provided, skip this question.*			**1**	**1**

Question	**Yes**		**No**	
Was the information presented valuable to you? *Please mark one.*	**8**			
Were you able to take action as a result of what you learned (Did you use what you learned in a valuable way?)	**8**			
Did the action you took as a result of what you learned achieve results? *Skip this question if the previous answer was 'no'.*	**7**		**not yet**	
Would you be interested in attending more tele-conferences?	**8**			
If the ECH were to hold face-to-face training workshops, would you be interested in attending if the topic were of interest to you?	**8**			
	20 miles	**50 miles**	**75 miles**	**100 miles or more**
How close to your location would training sessions need to be in order for you to attend in person?	**2**	**3**	**4**	**1**
If the ECH provided more tele-conference trainings, would noon or evening be better for you? *Please circle one.*	**Noon time trainings - 6**		**Evening trainings -1**	

What other training sessions should the ECH provide?

- Marketing, visual merchandising Bonnie: Greenhouse – pest, fungus control, heating, row covers, cold frames
- Record keeping, GAPs – what's required

What could the ECH do to improve its trainings?

- Praise, very good
- Have materials sent via regular mail and earlier
- I think you guys are doing and awesome job. Keep up the good work. Stacy it's such a pleasure speaking with you when I call in and Holly always has an answer for me.

Our initial trainings in May were not well attended. We are unsure if this is a factor of people being too busy at that time of year or if they were not publicized enough. Please give us your thoughts on the best time of year for us to hold trainings (either tele-conference or in person).

- Didn't know enough about the program for 1st sessions. Best time from Oct – March, demo trainings should be in the evening so no time needs to be taken off from a job
- Avoid June-Sept. Jan-March are good times
- May not publicized enough, otherwise very good and time of year doesn't matter
- Nov. 1st – April 15th is good. Farmers are too busy in May.
- Jan – Feb. would be best
- Jan – March. The rest of the year people are too busy in the garden
- Before spring works or after the harvest.

How progress has been made to achieve long term outcome measures for each project.
o The overall goal of the Producer Education Series is two-fold: to increase the amount of locally grown food on the market and to increase the number of producers selling directly to restaurants, grocery stores and farmers markets in North Dakota. This project will also have long term effects as future producers access the training materials via the online clearinghouse of information through the Entrepreneurial Center for Horticulture.

Additional information available (e.g. publications, web sites).

o Entrepreneurial Center for Horticulture at Dakota College web site:
http://www.dakotacollege.edu/ech.shtml

o Online clearinghouse of producer/market information:
http://www.dakotacollege.edu/brain/index.html

o Additional Producer Packets can be received by mailing Stacy Baldus, Dakota College at Bottineau ECH, 105 Simrall Blvd, Bottineau ND 58318-1159 or emailing: Stacy.Baldus@dakotacollege.edu

Contact person for the project with telephone number and email address.

Holly Rose Mawby, Dakota College
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Project D Northern Pulse Growers Association
Final Report

Title: **Evaluation of Fractionated Pea Protein Concentrate as Egg Replacers**

An outline of the issue, problem, interest, or need for each project.

The Center for Disease Control (CDC) estimates that food allergies affect up to 4% of the U.S. population (or 12.2 million people). Of these individuals, children account for 3 million of the allergen sufferers. Up to two-thirds of the food allergies in children are associated with eggs, meaning that eggs affect nearly 2 million children. The number of adults with egg allergies is believed to be approximately 0.5 to 1 million. However, many individuals do not have a true egg allergen but instead have an egg sensitivity or intolerance. A sensitivity or intolerance is a reaction to food without the production and release of antibodies called immunoglobulin E (IgE). However, some of the symptoms can be similar to an allergy. Thus, many individuals think they have an allergy but in fact have a sensitivity or intolerance to a food. The numbers of individuals with intolerances are not well documented as they are not considered a disease and therefore not tracked by the CDC. However, a recent study indicated that 53 and 32% of the surveyed people in the United Kingdom had intolerance to egg white and egg yolk, respectively. In the U.S. a figure of 8 to 10% was estimated. However, this was only an estimate and no real values were determined. Regardless, if 10% of the population is intolerant to eggs then 30.5 million people would have intolerance to eggs. Thus, a large segment of the population would benefit from egg replacers.

Replacing eggs as a protein source would allow the food industry to develop vegetarian food products. Although peas have been found to contain allergens, only a small percentage of the population was found to be sensitive to pea allergens. In fact, the Food and Drug Administration does not have a concern with pea allergens as it is not listed as one of the major 8 food allergens. Thus, the food manufactures would be attracted to an ingredient that would not require additional labeling. In addition, egg intolerance, which causes symptoms such as inflammation and diarrhea, is more widespread than the true egg allergens; therefore, creating food products without eggs would attract a wider population of consumers that at one time could not consume products with eggs. Collectively, the benefits to the food industry for using an egg replacer made from the modified pea protein and the consumer interest in egg-free products would drive demand for peas. This in turn would benefit producers of peas.

In summary, egg allergies and intolerances affect nearly 34 million consumers. Developing egg alternatives or replacers would allow consumers and food manufactures to produce foods that do not trigger an allergic or intolerance response. Product made with egg replacers would allow consumers to enjoy foods that traditional use eggs (e.g. cakes and cookies) without the worry of becoming ill. The objective of the proposed research is to develop product specification for use of pea protein concentrates or isolates as egg replacer in commercial refrigerated egg replacement products and in bakery items that utilize eggs. This project is significant due to the lack of good egg replacement products in the retail market place, specifically for consumers that are allergic or intolerant to eggs.

How the issue or problem was approached via the project(s).
Although pea and egg proteins are similar, isolation and modification of the protein will be necessary to develop an egg replacer from peas (*Pisum sativum*). The primary objective of the proposed research to study the feasibility of using modified pea proteins as egg replacers. The specific objectives included:

1. To hydrolyze the isolated crude pea protein using glucoamylase. Protease modification to the pea protein also will be investigated.

2. To establish appropriate post processes to dry the modified protein.

3. To evaluate and compare the functional characteristics of the modified pea protein against egg functionality in model test systems.

4. To evaluate and compare the functional characteristics of the best modified pea protein obtained from objectives 1-2 in food systems such as cookies and cakes. Other products such as waffle, pancake and muffins could be evaluated.

How the goals of each project were achieved.
Dry peas have been traditionally used as an ingredient in soups. The common uses include split peas, as a component in multi bean soups, and in canned soup products. However, peas have other functional benefits that could be exploited to create new ingredients. The objective of the proposed research was to develop methods for isolation of pea proteins and use these as egg alternative or replacer in commercial refrigerated egg replacement products and in bakery items that utilize eggs. The project had five basic outcomes. These included: 1. Process flow chart(s) of the pea protein fractionation process. 2. Process flow chart(s) of the pea protein modification process. 3. Product specifications or formulas for use of modified pea protein as refrigerated egg replacer products. 4. Product specifications for use of modified pea protein egg replacer products in bakery applications. 5. Materials promoting the use of pea proteins as egg replacers.

The general flow charts will be created to highlight the key steps of the extraction protocol. This flow chart will focus on the extraction and production of the pea isolate. However, the modification of the pea protein will require additional research beyond this grant proposal period. We evaluated two enzymes as indicated in the objects and found that the protease reduced functionality and the other glucoamylase did not significantly improve functionality. Therefore, no flow chart will be provided for the modification until other enzymes confer improvements in functionality. The development of process flow charts were based on the extraction of the pea proteins in laboratory and pilot scale extractions. The basic protocol can be found in the appendix. Completion of Outcomes 1 and 2 were based on research related to objectives one and two.

The use of pea isolates by consumers in “at-home” preparations such as cakes, cookies, waffles etc. was related to outcomes 3 and 4. The availability of an egg replacer for in home uses is limited and therefore the isolate specification was developed with consumers in mind. The only product specification is the level of protein in the isolate. The pea protein isolate must contain at least 80% protein to provide the functionality described above. We also have identified the level (i.e. ingredient use specification) of pea protein isolate required to replace eggs in products such

as cookies, cakes and waffles. The completion of outcomes 3 and 4 were based on the project objectives 3 and 4. In these objectives the basic functionality was first identified and then the best functioning (i.e. foaming) isolates were subjected to evaluation in cakes and cookies. Extracts with lower foaming capacities were not tested in the home-use products.

Materials were developed to promote the use of pea protein isolates and concentrates as an egg replacement in food products to complete outcome 5. The new brochure includes written information, charts and graphs showing product specifications, food formulas and photographs. The materials will be used to promote the egg replacement concept at trade shows, seminars and though the food industry media.

Results, conclusions, and lessons learned for each project.

The main findings from the research related to outcome one are: 1) roasting has a negative impact on protein extraction and the proteins ability to produce foam, 2) the optimal pH for maximum protein recovery is approximately pH10-11, and 3) the use of split peas over whole peas is recommend for protein extraction because the fiber in the whole pea interfered with the extraction of the protein. The findings related to outcome two are: 1) the drying process during the preparation of the pea protein isolate had only a small affect on foaming capacity, 2) the application of protease enzyme to the pea protein isolate did not affect foaming capacity, but the enzyme hydrolysis of pea proteins negatively impacted foam stability, and 3) adjustment of the pea protein solution to a neutral pH prior to foaming improved the foam capacity and stability.

The wet extraction protocol found to be ideal included the use of split yellow peas that were ground to pass a 30 mesh screen and a solution pH of 10. The use of a heat treated pea should be avoided as the extraction yield decreased when roasted ground peas were used in the extraction. Furthermore, the foaming capacity was greatly reduced for the protein isolated from heat treated peas. The spray drying or freeze drying produced protein extracts with similar foaming capacities and stabilities therefore the method of water removal does not appear to have a great impact on functionality in model systems. However, protease hydrolysis of the protein extract should be minimized as foam stability was negatively impacted.

Findings from the application stage of the activity are: 1) the egg white produced slightly better cake uniformity and softer texture, 2) the pea protein isolates produced cakes with comparable cake peak heights, 3) the cake made with pea protein isolates and concentrates produced denser cakes with greater moistness than those with eggs, 4) the pea protein isolates work better than the pea concentrates in regards to cake uniformity and cake height, 5) minimal differences were observed in functionality a spray dried pea protein isolate and that of a freeze dried pea isolate, 6) pea protein isolates produced cookies with greater moistness compared to cookies with eggs, 7) no difference in cookie spread or cookie height were observed between the cookies with spray dried pea protein isolate or with eggs, and 8) the pea protein isolates produced cookies with lower peak hardness indicating a softer texture.

Based on the above observation, the overall conclusion related to outcome four is that the pea protein isolates preformed comparable to eggs in the cookie formulas and were only slightly less functional in the cake formula as measure using objective methods. However, subjective measure

indicated that the appearance of the cakes with the pea protein or eggs were difficult to differentiate. The use of pea proteins in bakery products has proven feasible, especially for products that consumers could make at home such as cookies, cake, muffins and waffles.

No conclusions can be drawn at this time regarding the use of pea proteins as liquid egg alternative (outcome three). Additional research is needed to determine the correct modification that would allow the pea protein to form a structure similar to that of scrambled eggs.

How progress has been made to achieve long term outcome measures for each project.
Although pea and egg proteins are similar, isolation and modification of the protein will be necessary to develop an egg replacer from peas (*Pisum sativum*). The goals of the project is to develop product specification for use of pea protein concentrates as egg replacer in commercial refrigerated egg replacement products and in bakery items that utilize eggs. In this research we accomplished extensive studies on the isolation of the protein and the use of the isolated protein in baked products. Pea proteins as liquid egg replacement product were also investigated. One goal not met was the utilization of modified pea proteins as a liquid egg product.

The project was divided into two main phases. The first phase was the isolation of the pea proteins while phase two was the application of the pea protein isolates in baked products and as a liquid egg product. The following summary provides detailed results related to the specific outcomes.

Phase 1. Protein Isolate Extraction Phase

The first phase of the project was to identify the best extraction methods for isolating pea proteins. The isolation process is the first step in developing information for outcomes 1 and 2 (Figure 1). Outcome 1 was the development of a process flow chart of the pea protein fractionation process. Outcome 2 was the development of a process flow chart of the pea protein modification process. We identified the effect of solvent pH on protein extraction and foaming characteristics of these extracts. Furthermore, the extraction of protein from split peas, whole peas, roasted split peas and whole peas were also used to determine the best extraction protocol. The extraction was performed using water that had been adjusted to various pH values ranging from 3-10. After the key parameters were identified for outcome 1, the isolated proteins were subjected to enzyme modification (outcome 2). Extraction yield and foaming capacity were determined for the samples and used as the measure for determining the best extraction protocol.

In doing the extraction, we found:

- Non-roasted samples have much higher protein yields than roasted samples.
- Protein yield from split samples was higher than whole pea. Whole – roasted samples yield the least amount of protein.
- Reducing the pH from 10 down to pH 7 caused a slight decrease in protein yield. However, a significant decrease in protein content occurred in all samples when the pH dropped from 7 to 5. At pH 5, almost no protein was collected from roasted samples (both whole and split) and very little from non-roasted peas.

- Color of proteins collected from roasted samples was darker than those collected from non-roasted peas.
- Roasted samples (both split and whole) were easy to be dispersed in water but created thicker suspensions, resulting in difficulty in pH adjustment.
- Non roasted samples were harder to dissolve but were easy to adjust pH due to forming thin suspension
- Whole non-roasted samples had a caking issue during suspension, requiring more time to dissolve.
- The protein extracts of non-roasted peas (both split and whole) had better foaming capacities than the protein from the roasted samples.
- The protein foaming capacity and stability were comparable for a pea protein isolate that was prepared via spray drying and by freeze drying.
- The enzyme modification using proteases slightly improved foam formation but produce foam with less stability.
- Adjusting the pH of the protein solution to a neutral level (pH 6.45) resulted in a pea protein with good foam capacity and stability.

Conclusions directly related to outcome 1 are: 1) roasting has a negative impact on protein extraction and the proteins ability to produce foam, 2) the optimal pH for maximum protein recovery is approximately pH10, and 3) the use of split peas over whole peas is recommend for protein extraction because the fiber in the whole pea interfered with the extraction of the protein.

Conclusions directly related to outcome 2 are: 1) the drying process during the preparation of the pea protein isolate had only a small affect on foaming capacity, 2) the application of protease enzyme to the pea protein isolate did not affect foaming capacity, but the enzyme hydrolysis of pea proteins negatively impacted foam stability, and 3) adjustment of the pea protein solution to a neutral pH prior to foaming improved the foam capacity and stability.

The overall conclusion related to outcomes 1 and 2 is that the production of a pea protein isolate can be accomplished using a wet extraction protocol using a pH 10 solution without prior heat treatment of the peas. However, the isolation of the protein from split peas is ideal as the fibrous hull was found to be problematic during the extraction protocol involving whole peas. Spray drying or freeze drying produced protein extracts with similar foaming capacities and stabilities therefore the method of water removal does not appear to have a great impact on functionality in model systems. However, protease hydrolysis of the protein extract should be minimized as foam stability was negatively impacted.

Phase 2. Application of the Protein Isolate

The second phase (i.e. application phase) of this project is related to outcomes 3 and 4 of the proposal. These outcomes related to the application of modified pea protein as refrigerated egg replacer products similar to egg beaters while outcome four related to the use of pea protein to replace eggs in bakery applications. The pea protein isolate obtained from the optimal extraction conditions (pH 10, non-heat treated milled split peas, 2 hours and room temperature) were used in the preparation of liquid refrigerated egg products and bakery items such as cakes and cookies.

Cakes

The functionality of pea isolates and concentrates were evaluated. The functionality of pea proteins in cake batters were evaluated using standard commercial cake mixes. The goal of the cake and cookie preparation was to utilize pea proteins in cake mixes for home use. Thus, the formulas included chocolate and white cake mixes from a commercial supplier. White cakes prepared using peas are presented in Figure 2.

In completing the cake production, we found:

The cakes had similar diameters, shrinkage values and weights compared to cakes made with eggs (Table 2). The cake made with eggs did weigh 5-9 grams more than the cakes prepared with pea proteins. Although the weight differences were small, the impacts of this difference were not significant. As expected, a significant reduction in cake weight was observed. The batter weights were all 461 g prior to baking, thus the difference in the loss of moisture during baking was likely caused by the cake location in the oven during baking.

Cakes made with pea concentrate, spray dried pea protein isolate and eggs had moistures of approximately 31% while the cake made from freeze dried pea isolate had a moisture content of 38%. The difference in moisture content had minimal impact on moistness scores. All cakes scored 10 points for moistness except for the cake made with eggs, which scored 8 points. The cake made with eggs had a slightly dry texture compared to the cakes made with pea protein. However, all cakes were very tender and soft; thus, the small difference in moistness between cakes might be mitigated due to the favorable tenderness and softness of the cakes. The texture analysis of a chocolate cake showed that the cakes made with pea proteins had softer texture (i.e. lower peak load values) after 1 day of storage than cake made with eggs (Figure 3). However, the chocolate cakes made with pea concentrate and spray dried protein isolate had slightly higher peak load than the cake containing eggs after 2 days of storage. The chocolate cake made with freeze dried pea protein isolate still had lower pea load values compared to cake made with eggs after 2 days (Figure 3).

The heights and contours of the white cakes were similar. However, small differences could be observed visually (Figure 2). The heights at the center of the cakes were all very close with the pea isolates performing better than the pea concentrate (Figure 4). The cakes made with protein isolates had center heights that were 0.3-0.4 cm lower than the height of the cake made with egg. This value jumped to 0.8 cm for the cake made with pea concentrate. The cake height of the pea protein containing cakes was 0.6-0.8 cm lower than the cake made with eggs at the 3/5 mark on the cake. The freeze dried pea isolate performed well in cake formulas and was comparable to the egg. Although differences were observed using a measuring template, visual observations indicate that the cakes were difficult to differentiate (Figure 2). In contrast to the white cakes, the chocolate cakes containing pea proteins had significantly lower heights at the center than the cake made with eggs (Figure 5). The differences observed between the white and chocolate cakes may be related to the eggs used in the studies. Jumbo eggs were used in the chocolate cake experiment while large eggs were used to make the white cakes.

Cookies

The cookie parameters of a sugar-snap type cookie obtained from the modified method 10-53.01of the AACC International are presented in Table 2. The official method uses nonfat dry milk in the formula to evaluate flour quality. However, we used the formula to evaluate the replacement of the nonfat dry milk. Another goal of the project was to replace eggs in home prepared products. Thus, we also evaluated a homemade chocolate chip cookie formula with spray dried pea protein isolate. This formula was based on a traditional cookie recipe and therefore the result would be applicable to most chocolate chip cookie recipes.

In completing the cookie production, we found:

The cookie width was greatest for the cookies containing eggs (Table 2, Figure 6). However, the cookies containing spray dried pea protein isolate had comparable widths to those of the egg containing cookies. The average width prior to baking was 5 cm. Thus, minimal spreading was observed during baking regardless of the treatment. The average cookie heights were similar except for the cookies containing dried eggs. This was expected because as the cookies spread the height decreases. The spreading of the cookie containing eggs may have caused an increase in moisture loss as indicated by the lower cookie weight (Table 2). The cookies with pea proteins were similar, regardless of whether the concentrate or isolate was used. The hardness value as measured by texture analysis indicates that the pea protein isolated had a tenderizing effect compared to the other treatments (Table 2). The peak hardness values of the cookies with the isolates were 809 and 831 g while cookies with dried eggs had hardness values of 1555 g. Lower moisture could contribute to the higher hardness values.

A subjective evaluation of the chocolate chip cookies indicated that the cookies with the protein isolate had a moist texture while the chocolate chip cookies containing eggs had a dried and crisper texture. The average cookie thicknesses were 1.36 and 1.51 cm for the pea protein and egg containing cookies, respectively. The average cookie widths were 7.43 and 7.32 cm for the pea protein and egg containing cookies, respectively. The chocolate chip cookies were very comparable in the context of height and widths; however, the darker color observed in the cookies containing egg may not be preferred by consumers (Figure 7). Given that a uniform baking time was used between batches of cookies we suspect that Maillard browning was favored in the formulas containing fresh eggs. The sugar snap cookies previously describe used dehydrated eggs, thus glucose may have been converted to an oxidized form to prevent browning during dehydration. Thereby, browning was minimal in the sugar snap cookies compared to the use of a fresh egg in the chocolate chip cookies.

Conclusions from the application stage of the activity are: 1) the egg white produced slightly better cake uniformity and softer texture, 2) the pea protein isolates produced cakes with comparable cake peak heights, 3) the cake made with pea protein isolates and concentrates produced denser cakes with greater moistness than those with eggs, 4) the pea protein isolates work better than the pea concentrates in regards to cake uniformity and cake height, 5) minimal differences were observed in functionality a spray dried pea protein isolate and that of a freeze dried pea isolate, 6) pea protein isolates produced cookies with greater moistness compared to cookies with eggs, 7) no difference in cookie spread or cookie height were observed between the cookies with spray dried pea protein isolate or with eggs, and 8) the pea protein isolates produced cookies with lower peak hardness indicating a softer texture.

Overall conclusion related to outcome four is that the pea protein isolates preformed comparable to eggs in the cookie formulas and were only slightly less functional in the cake formula as measure using objective methods. However, subjective measure indicated that the appearance of the cakes with the pea protein or eggs were difficult to differentiate. From these results, additional studies using more complex sensory models may be required to differentiate the cakes made with pea protein isolates and cakes made with eggs.

Problems and Delays

One goal not met was the utilization of modified pea proteins as a liquid egg product (Outcome 3). The goal of this part of the study was to make a liquid egg product that could be an alternative to liquid egg products such as egg beaters. In this phase of the project we evaluate approximately 25 pea formulas in an attempt to create a product that would produce a structure similar to scrambled eggs. The formulas utilized freeze dried or spray dried pea isolates and were not modified using enzymes such as transglutaminase. The lack of scramble egg-like structure that resulted led to the conclusion that a modification of the pea proteins with enzymes would be needed. Due to time limitations and the success of the pea protein in the initial bakery products studies, we decided to refocus our attention on the bakery and cereal-based products as indicated above.

Future Project Plans

The whole peas in general were more difficult to achieve a higher protein level because of the increased viscosity that occurred during the extraction. This indicated that the fiber in the hull component was likely responsible for the increased viscosity of the solution. This may be important to provide the needed structure that pea proteins lacked. Therefore, additional work on the liquid egg alternative or replacer will focus on the inclusion of the fiber component and the enzymatic modification.

Additional information available (e.g. publications, web sites).

More information about pulses including sources of pulses and pulse products can be found at the USA Dry Pea and Lentil Council website at www.pea-lentil.com or the Northern Pulse Growers Association website at www.northernpulse.com. Additional formulas using pea protein as an egg replacement in baked products are available through the Northern Pulse Growers Association website.

A brochure developed as a result of this project is attached as Attachment A.

Contact person for each project with telephone number and email address.

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Institutions: Northern Pulse Growers Association (NPGA), North Dakota State University (NDSU), Northern Crops Institute (NCI)

Appendix – Tables and Figures

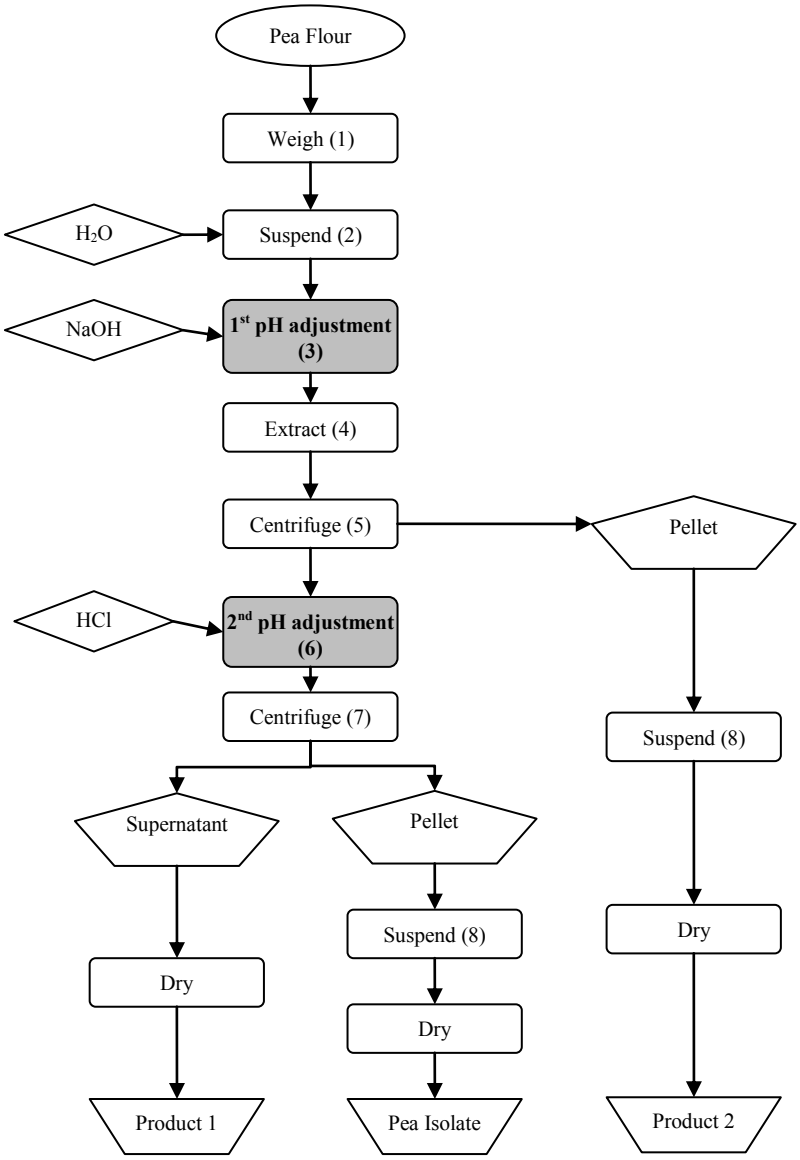
Process flow chart	Explanation
	(1) 20.00 g for lab scale (2) 150 ml H_2O in 250ml bottle. Mix. (3) Add 1 N NaOH to bring pH to values of 10 to 11. Amount may vary depending on original solution pH. (4) Stir for 30-45 minutes (5)10000 rpm in 20 minutes (6) 1 N HCl to drop pH to 4.5 (7) 10000 rpm in 20 minutes (8) Suspend pellet after centrifuge by adjusting pH of the solution to 6.9-7.1 prior to drying. Drying can be accomplished by freeze drying, spray drying, or vacuum tray drying. *Note: Shaded boxes represent critical steps in the process.*

Figure 1. The laboratory flow chart for the preparation of the pea isolate. Pilot scale followed a similar process except that materials levels were scaled to 20 lbs of pea flour.

A

Pea Concentrate | Freeze Dried Pea Isolate | Spray Dried Pea Isolate | Eggs

B

Figure 2. The white cakes prepared from pea concentrate, peas isolates, and eggs.
The top view is represented in A while B represents the cross-section of the corresponding cake.

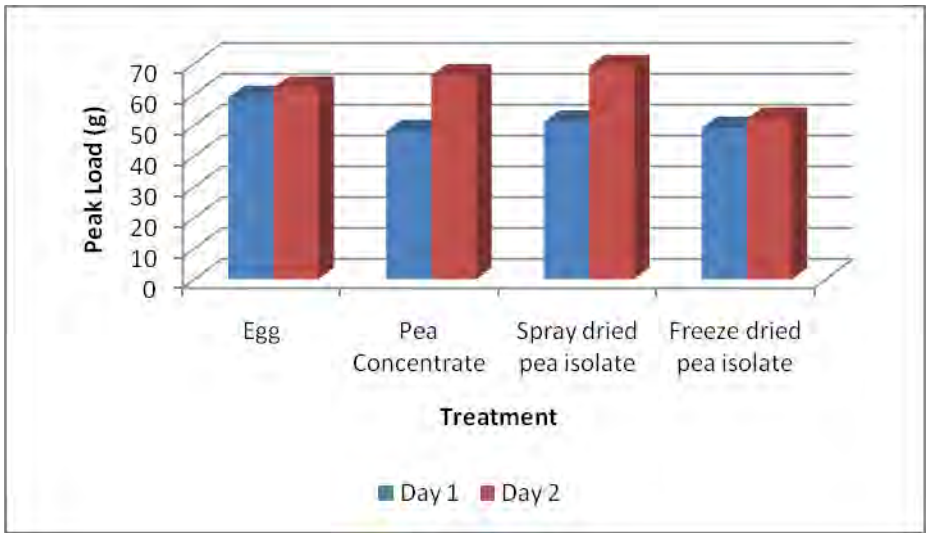


Figure 3. Texture analysis (Peak load) for chocolate cakes prepared from pea protein concentrate, pea protein isolates, and eggs. Analysis was completed after day 1 and 2 of storage.

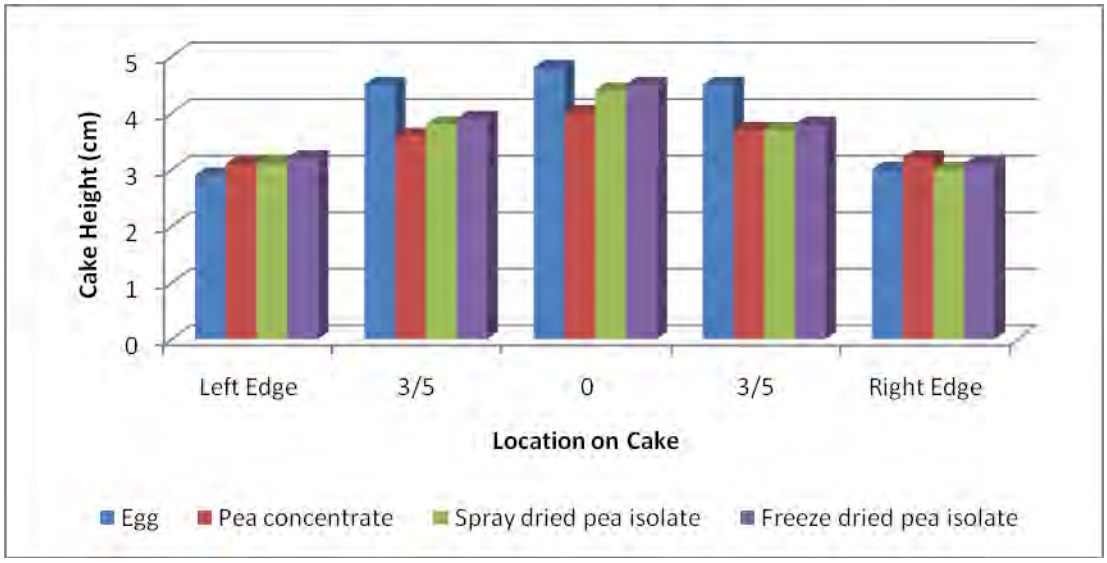


Figure 4. The heights and contour of white cakes prepared from pea concentrate, peas isolates, and eggs. The 0 represents the center of the cake while the 3/5 indicates a measurement taken at 3/5 the distance from the edge of the cake.

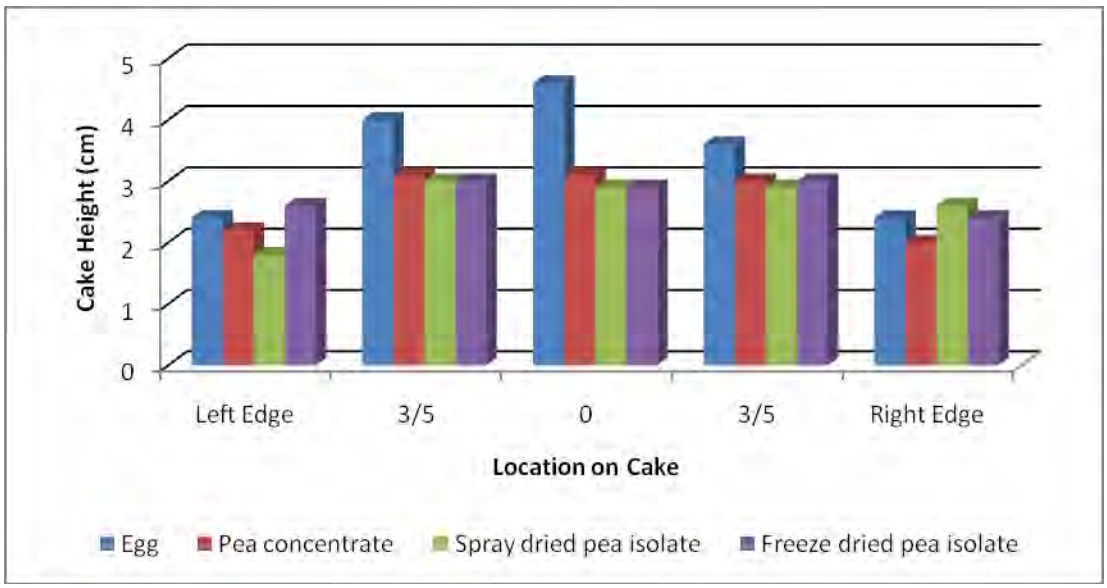


Figure 5. The heights and contour of chocolate cakes prepared from pea concentrate, peas isolates, and eggs. The 0 represents the center of the cake while the 3/5 indicates a measurement taken at 3/5 the distance from the edge of the cake.

Figure 6. The sugar-snap type cookie prepared from nonfat dry milk, pea proteins, and eggs. Cookies shown in duplicate. From left to right: nonfat dry milk, pea protein concentrate, freeze dried pea isolate, spray dried pea isolate, and eggs.

Figure 7. The chocolate chip cookie prepared from a common household recipe. The formulas contained either egg (left) or pea protein isolate (right).

Table 1. Affect of protein source on white cake parameters

Protein Source	Average diameter (cm)**	Shrinkage value (cm)**	Average weight (g)**
Egg	19.5	0.8	400
Pea protein concentrate*	19.4	0.9	393
Spray dried isolate*	19.6	0.7	391
Freeze dried isolate	19.4	0.9	395

*Commercial sources of pea protein concentrate and isolates.

** The average values were determined from 2 cakes according to the AACC International method 10-91.01

Table 2. Affect of protein source on sugar-snap type cookie parameters

Protein Source	Average width (cm)**	Average height (cm)**	Average weight (g)**	Average hardness value (g)***
Non-fat dry milk	5.73	1.92	22.2	2550
Dried egg	6.03	1.77	21.8	1555
Pea protein concentrate*	5.79	1.96	22.2	1308
Spray dried pea isolate*	5.95	2.02	22.0	809
Freeze dried pea isolate	5.80	1.99	22.3	831

*Commercial sources of pea protein concentrate and isolate.

** The average values were determined from 6 cookies according to the AACC International method 10-53.01.

*** The average values were determined from 4 cookies using a compression test with a trigger load of 10 g, deformation of 10 mm, and a speed of 5 mm/s.

Project E -North Dakota Nursery and Greenhouse Association Final Report

Title- Encouraging the Public to buy locally grown Trees, etc

Outline of the Issue/Need for Projects

There is currently no specific statewide marketing program in North Dakota to encourage the buying public to purchase North Dakota grown nursery and bedding plant products.

Projects to Address the Issues
I. Identify current growers and retailers of North Dakota Nursery and Floriculture products.
II. Educate professional growers and retailers in North Dakota about the program and give them a chance to label, market their locally grown products, and be listed as a source on the NDNGA website. The website is www.ndnga.com.
III. Develop a marketing campaign to encourage the buying public to purchase North Dakota grown nursery and bedding plant products.
IV. Update and then promote the NDNGA website as a resource for the buying public to find growers and retailers of North Dakota grown nursery and bedding plant products.

I. Identify Current Growers and Retailers of North Dakota Nursery and Floriculture Products.

The North Dakota Nursery and Greenhouse Association maintains a membership database and also a list of non-members that grow or sell nursery and floriculture products. These lists were updated using Internet searches, word of mouth, public records of nursery listings, and Extension and Forest Service information.

Project Goals Achieved
Approximately 200 individuals and businesses were identified as potential growers and or retailers of nursery and bedding plant crops in North Dakota.

Results, Conclusions, and Lessons Learned
Developing and upgrading the grower listing took some time, but was fairly easy to do using Internet searches. Many of the plant retailers are smaller and seasonal only so they were harder to track down. Most of them buy plants from NDNGA members so we were able to locate some of the retailers via word of mouth. Plant retailers in border communities such as Moorhead, MN, presented another challenge, but it was decided to include them if they sold plants grown in North Dakota. Also, it was decided to include landscaping firms if the firms installed North Dakota grown plants. Finally, sod farms were included if the sod was grown in North Dakota.

II. Educate professional growers and retailers in North Dakota about the program and give them a chance to label, market their locally grown products, and be listed as a source on the NDNGA website – www.ndnga.com.

Project Goals Achieved
Letters were sent out to 68 NDNGA members and 149 non- NDNGA members thought to be producers of nursery, bedding plants, or horticultural products. The letters informed them of the grant purpose and the media campaign being developed. A pre-addressed and stamped post card was included that could be returned with their contact and location information. This information was then used to develop the website listing. Informative handouts were also given to landscapers attending a hardscape class sponsored by the NDNGA on April 8th in Fargo which they could return with information for the website listing.

Results, Conclusions, and Lessons Learned
The NDNGA received the successful grant notification March 27th. We quickly worked to get the information out to the people in the horticultural industry who were already at that time very busy with the spring crop production. In addition, due to record snowfall, spring rains, and melting conditions, the entire state of North Dakota dealt with record flooding and high water conditions. This affected many of the nurseries and bedding plant producers across the state. Despite the late start on the grant work and the harsh flooding conditions, 49 producers and retailers submitted their information to be listed on the website.

III. Develop a marketing campaign to encourage the buying public to purchase North Dakota grown nursery and bedding plant products.

Project Goals Achieved
- NDNGA President, Sarah Liljestrand, and Executive Director, Mary Holm, met on April 7th to develop the wording to be used for the North Dakota grown advertising campaign. Previous input from North Dakota Forest Service and Extension Staff was utilized to develop a list of the economic, health, and environmental benefits of buying locally grown horticultural products which was the focus of the ad campaign.

- The NDNGA website was incorporated into the ad campaign so consumers could find retailers of North Dakota grown products.

- Sarah Liljestrand developed and implemented the video ad campaign for the radio and TV stations. She had previous experience producing video ads for her own garden center. She already had some pictures of horticulture crops but needed more images for the video production. We were able to obtain more high-quality pictures from the All American Selections program and from the North Dakota Department of Agriculture. Sarah put the images together on her computer to develop the video, and then worked with Mike Morris at KVLY in Fargo to add the audio portion of the ad. When finished, the ad was distributed by the North Dakota Broadcasters Association.

- Mary Holm worked with the North Dakota Newspaper Association to develop and distribute the print ad for the North Dakota grown promotion.

Results, Conclusions, and Lessons Learned
- The North Dakota Broadcasters Association accepted the NDNGA North Dakota grown ad into its (Public Education Partnership) PEP Program. They felt it was a good campaign to benefit all the people of the North Dakota. This allowed the NDNGA to pay $8,000.00 for a statewide campaign and in return received 2,839 – 30 second spots valued at $25,519.00. The ads ran throughout the month of May.

- NDNGA worked with the North Dakota Newspaper Association to develop a print ad that ran on 5/22/09 in the daily papers and twice in the weekly papers (weeks of 5/11 and 5/18) during the normal prime horticultural product buying season. $8,736.32 was spent on this campaign, and we reached 280, 873 households.

- To get additional exposure in the large Fargo area, NDNGA worked with House To Home magazine to develop a full page ad which ran in the early June issue. House To Home is a supplement included in the Fargo Forum newspaper. House To Home also felt this was a very worthwhile advertising campaign and so gave the NDNGA a full-page ad for $1,000.00 (normal rate is $2,300.00). This full-page color ad reached 35,000 subscribers to the Fargo Forum, plus an additional 11,000 magazines were distributed throughout high traffic Fargo area businesses.

The main lesson learned concerned the PEP Program. While it was very worthwhile in providing a great deal on advertising, we found it was not effective in one of our major target areas. Several NDNGA Board members live and work in the Fargo-Moorhead area, and they reported never seeing or hearing our ad. When the PEP Campaign Record of Performance came back to the NDNGA, we found that none of the radio or TV stations in the Fargo area had carried the ad. The ND Broadcasters Association does control which of their members choose to carry PEP ads. The stations located in the Fargo area said they had already sold their advertising time and elected not to participate in the NDNGA PEP Program. If we receive another grant in the future to promote horticultural products, the NDNGA will work directly with regional stations in order to guarantee reaching the target audiences.

IV. Update and then promote the NDNGA website as a resource for the buying public to find growers and retailers of North Dakota grown nursery and bedding plant products.

Project Goals Achieved
- NDNGA worked with our website maintenance company, Samek Services, to develop a locator map of businesses that grow and/or sell North Dakota grown products. This map was incorporated in the NDNGA website and was active by the beginning of May 2009 just in time for the prime horticultural product buying season.

-A counter was installed on the NDNGA Website in order to track hits to see if the North Dakota Grown advertising campaign is effective.

- The NDNGA website was prominently featured in all the ads run through the TV, radio, newspapers, and House To Home magazine. It serves as a locator for Internet savvy consumers to find where they can purchase North Dakota grown horticultural products

Results, Conclusions, and Lessons Learned

- We are very pleased with how the website locator map turned out. We feel it is simple to use even for people that are not very technology proficient. Yet, it references growers and retailers across the entire state so consumers easily find them, and contact information is provided also.

- The NDNGA is monitoring website hits and comparing the numbers to previous tracking. During December, 2007, the NDNGA site averaged 2 – 3 visitors per day. Since, the North Dakota grown advertising campaign began on May 1, 2009, the site has had 11,902 visitors or an average of 87 – 88 visitors per day.

Because of the late start on the project, and then the tremendous flooding damages experienced by many growers and retailers, getting them listed on the website will be an ongoing project. As the growers and retailers have time to submit their information, they will be added to the locator map.

Long Term Outcome Measures

The following were the Expected Measurable Outcomes as included in our original grant application:

- This grant will make it possible to reach 280,948 North Dakotans through the printed media to tout the benefits of purchasing locally grown plant materials. This has been completed. There were actually 75 fewer households reached due to newspaper subscription decrease from 2008 (when grant application was completed) and May 2009 (when ads were placed and grant funds were spent).

- It will make it possible to reach the entire state population through the broadcast media (radio and TV) to encourage the health and economic benefits of buying locally grown plants. This has been completed. The Fargo area was under covered with radio and TV ads, but was covered with two print ads instead.

- It will make it possible to develop an Internet Website map showing the locations where locally grown plant materials may be purchased. This has been completed. However, the map will be updated continually as additional growers and retailers send in their information.

- The success of the program will be measured by surveying participating growers to see if their customers have a buying preference for North Dakota grown products. The growers and retailers surveyed said this was another bad year for sales due to the economy and especially the weather. Many reported good vegetable sales as consumers continue to expand growing their own gardens and are increasingly aware of and concerned about where their plants and food are coming from.

- We will also track website hits to compare with previous years to see if the buying public is seeking the locations of North Dakota plant producers/sales outlets. This was completed and will be ongoing. A new counter was installed on the NDNGA website the beginning of May specifically to track the effectiveness of the advertising campaign. In previous tracking, the NDNGA website averaged 2 – 3 visits per day. Since the North

Dakota grown advertising campaign started, the site is averaging 87 – 88 visits per day, and has had 11,902 visits since May 1. This has greatly exceeded expectations, but shows that people are using it to find North Dakota grown horticultural products which is absolutely tremendous!

Contact Information

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Project F North Dakota Grape Growers Association
Final Report

Title: Characteristics and Economic Contribution of the North Dakota Grape Industry

Outline of the Issue:
Interest in commercial wine making has increased considerably in North Dakota, but because the commercial grape and wine industry is so new, little is known about the characteristics and nature of the grape and wine sector in North Dakota. Many nearby states have examined the effect of the grape and wine industry on their state's economy, however no comprehensive study of the economic impact of the grape and wine industry in North Dakota has been conducted. Accordingly, this study was undertaken to examine the characteristics of grape growers, vineyards, and wineries and measure the economic contribution of the North Dakota grape and wine industry.

Approach:
To accomplish study objectives a survey of grape growers and wineries was conducted. A list of North Dakota grape growers and wineries was complied and a mail questionnaire was developed to solicit demographic, financial and operational characteristics of grape growers and wineries in North Dakota. The questionnaire was mailed to North Dakota grape growers and wineries. Survey data was complied and analyzed. Results are available in Attachment B.

Project Goals Achieved:
Survey data was analyzed and summarized using standard descriptive statistics. Results were used to describe the characteristics of the state grape growers, vineyards and wineries and their economic contribution.

Results and Conclusions:
Winery and vineyard operations in North Dakota are primarily recently established hobby operations that at this time generate very little economic activity. In-state sales of grape and wine products and expenditures for operational inputs are modest at best. Total sales are similarly small. The economic contribution of the North Dakota grape and wine industry is consistent with an emerging sector. Considering there are 9 licensed wineries in the state, all of which have been established in the last 8 years, the results are not unexpected. On a positive note, nearly two-thirds of respondents plan expansions in both the number of vines and size of their properties. Further about one-third of respondents would like to add a visitor component to their vineyard or winery operation. Clearly there is room for substantial growth in the sector in North Dakota. As the sector grows and expands the economic significance of the sector can be revisited. Findings from this effort will provide an effective baseline with which to measure growth.

Attachment B- **Characteristics and Economic Contribution of the North Dakota Grape Industry**

Additional Information:
A NDSU Department of Agribusiness and Applied Economics Staff Report #10-004 will be published and posted on http://ageconsearch.umn.edu/ .

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pea protein

EGGS OPTIONAL

Good things come in small packages so it's no big surprise that the protein portion of a pea would offer food processors and consumers a functional and affordable egg alternative. Using pea protein isolates and concentrates, food scientists are solving many egg-less dilemmas. This latest application expands the use of pea protein which has already found its way into healthy, protein-fortified or gluten-free baked goods, snacks, cereals, pastas, energy bars and beverages. (For more on those uses, flip to page 8).

Pea protein is already recognized as high quality, with an amino acid balance that complements other common ingredients such as wheat protein. News that pea protein can now mimic the egg in pastas and baked goods will be welcomed by millions worldwide who find the egg neither incredible nor edible because of egg allergies.

Food scientists are busy unlocking the egg-like potential of pea protein to the delight of many—especially children—who must resist some of their favorite foods because of a sensitivity or actual allergic reaction to eggs. Now they can enjoy the traditional taste and texture of everyday fare from waffles to spaghetti to muffins, cookies, and even chocolate cake, without worry. Food manufacturers also benefit from a clean label, because unlike soy or milk protein, pea and pea derivatives are not considered one of the top eight allergens they must disclose.

NOTHING TO SNEEZE AT

Food allergies affect up to 4% of the population—some 12.2 million people—in the U.S. alone, according to the Centers for Disease Control (CDC). The National Institute of Health (NIH) ranks eggs as the fourth most common food to trigger allergic reactions in adults, right behind fish, peanuts and tree nuts. CDC numbers show that children are even more prone to egg allergy, with two-thirds of their food allergies associated with eggs. Next to milk, it's the most common allergy in those younger than 16, affecting 1.5% to 3.2% of children in the U.S., according to the American Academy of Allergy, Asthma & Immunology (AAAAI).

Egg allergy isn't the temporary problem once assumed. Results from a recent and large John Hopkins study found that far fewer people than previously thought actually outgrow egg allergies, with 32% of those diagnosed as kids continuing to suffer reactions to egg after the age of 16, many of them throughout adulthood.

EGG-FREE ECSTASY

Imagine a busy mother being able to offer her egg-sensitive child goodies such as walnut-chocolate chip banana bread, coconut cake, sunflower cookies and blueberry muffins. Or, a treat such as a waffle cone, as well as breakfast fare like strawberry pancakes and hazelnut biscotti. A quick, simple supper of spaghetti and meatballs or cheese ravioli is no longer off-limits because of an egg allergy.

A "NICHE" MARKET OF 30 MILLION?

Sensitivities to egg and egg-containing products explodes the market for a functional egg replacer to more than 30 million people. Indeed, many people who can't tolerate egg products don't have an actual egg allergy as medically defined, but rather a sensitivity to eggs. Egg intolerance produces many of the same symptoms as egg allergy, such as inflammation and diarrhea. In England, some 53% of those recently surveyed had intolerance to egg white and 32% to egg yolk. While the CDC does not track food sensitivities, conservative estimates for the U.S. scaled that number back to 8-10% of the population—still nearly 34 million consumers. That's a lot of folks looking for an egg-free eating experience.

DON'T THINK "GREEN"

In fact, the only thing green about pea protein is the environment. As with pea fiber and pea starch, pea protein isolates and concentrates come from dry split peas. Because peas are a legume plant that naturally makes and returns nitrogen fertilizer back into the soil, they are as healthy to grow as they are to eat. But in the case of pea protein, that's where the "green" stays. Non-GMO and low allergenic pea protein concentrates and isolates are creamy-white powders that blend conveniently into dry ingredients, liquids and batters.

WELL-SUITED SURROGATE

Pea and egg proteins are similar and both have similar emulsion characteristics. Pea protein has excellent foam stability, comparable to egg albumin. Depending on the product made, independent controlled baking tests found that pea isolates and concentrates can perform better than, equal to, or only slightly less functional than eggs in cookies, cakes, muffins or waffles.

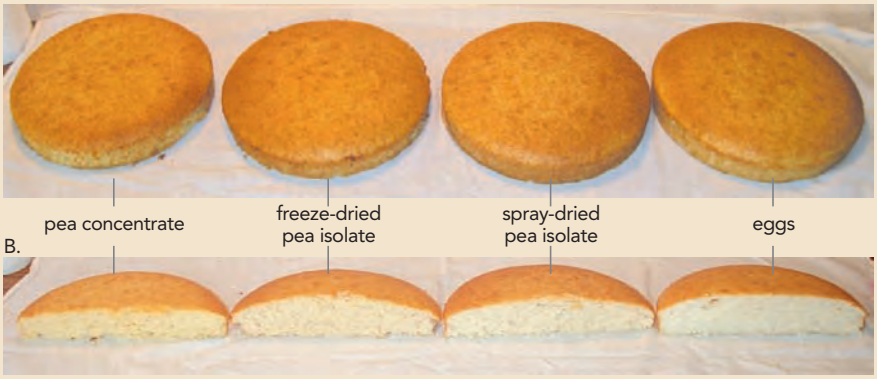
PUTTING PEA PROTEIN THROUGH THE PACES

Food scientists at North Dakota State University (NDSU) tested the egg replacement functionality of a pea protein isolate containing 80% protein and a pea protein concentrate containing 50% protein in standard commercial cake mixes as well as cookies.

THE CAKE TEST

Both white cake and chocolate cake mixes were made with eggs, pea protein concentrate, freeze-dried pea protein isolate and spray-dried pea protein isolate. Pea protein produced denser cakes with greater moistness than cakes made with eggs. Pea protein isolates produced cakes with comparable cake peak heights. Objective measurements found the egg cakes had slightly better cake uniformity and a softer texture, but all the cakes were deemed very tender and soft. Indeed, subjective measures found the pea protein and egg cakes difficult to differentiate in appearance. The pea protein cakes had

A.



The white cakes prepared from pea concentrate, pea isolates, and eggs. The top view is represented in A while B represents the cross-section of the corresponding cake.

FEASIBLE AND FUNCTIONAL

Thus far, NDSU food scientists concluded that pea protein isolates not only performed comparable to eggs in their preliminary tests, but proved to be a viable alternative to the egg—especially in popular consumer baked goods. Expect to see results from more complex sensory tests in the future.

While NDSU put pea proteins through controlled baking tests, food scientists at Northern Crops Institute (NCI), an outreach food and crop facility also in Fargo, ND, optimized recipes using pea protein concentrate. Less refined than pea protein isolates, concentrates are produced via a dry milling process. Dry milled concentrates have slightly less protein than protein isolates; more starch and can enhance texture and volume in many products. NCI replaced eggs in common baking formulas with a dry-milled pea protein concentrate consisting of ~50% protein and ~12% starch. When recipes were optimized, the pea concentrate performed exceptionally well as an egg replacement on a variety of baked products and pastas (see pages 5-7 for recipes and nutritional facts).

MISTAKE-PROOF PASTAS

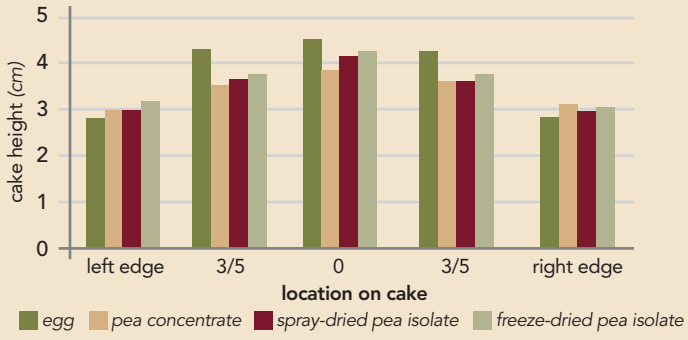
Pasta production at NCI showed that replacing eggs with pea protein concentrate not only lowers costs, but improves firmness, maintaining that desired texture even after overcooking. Expect classic bright golden yellow color, not only with traditional semolina, but even when using white wheat.

Al dente pasta	cooking time *(min)*	avg. firmness *(gcm/strand)*	avg. cooked weight *(g)*	avg. cooking loss *(%)*
100% Semolina	11	12.8	69.7	6.2
90% Semolina-10% pea protein concentrate	12	14.8	68.1	6.0
98% Semolina-2% egg white powder	12	15.7	68.8	5.0

Overcooked pasta	cooking time *(min)*	avg. firmness *(gcm/strand)*	avg. cooked weight *(g)*	avg. cooking loss *(%)*
100% Semolina	17	9.3	81.8	7.0
90% Semolina-10% pea protein concentrate	18	11.5	79.6	6.8
98% Semolina-2% egg white powder	18	11.7	78.1	5.6

similar diameters, shrinkage values and weights compared with cakes made with eggs. Pea protein isolates produced cakes with comparable cake peak heights.

Cakes made with pea protein scored a 10 for moistness compared with an 8 for cakes made with eggs, with testers concluding that cakes made with eggs had a slighter dry texture compared with cakes made with pea protein. Texture analysis on the chocolate cakes found that those made with pea protein had softer texture (lower peak load values) than the egg cakes after one day of storage, but slightly higher peak loads than egg cakes after two days of storage. Functionally, freeze-dried pea isolate performed similar to spray-dried isolate. *(Cookie trial shown on next page.)*



The heights and contour of white cakes prepared from pea concentrate, peas isolates, and eggs. The 0 represents the center of the cake while the 3/5 indicates a measurement taken at 3/5 the distance from the edge of the cake.

Affect of protein source on white cake parameters

protein source	avg. diameter *(cm)***	shrinkage value *(cm)***	avg. weight *(g)***
egg	19.5	0.8	400
pea protein concentrate*	19.4	0.9	393
spray-dried isolate*	19.6	0.7	391
freeze-dried isolate	19.4	0.9	395

** Commercial sources of pea protein concentrate and isolates.*

*** The average values were determined from two cakes according to the AACC International method 10-91.01.*

Chocolate cupcake on left had 100% of eggs replaced with pea protein. Cupcake on right contained eggs and no pea protein.

While pea isolates offer a more neutral flavor profile, pea protein concentrates are well-suited to products that already contain a flavoring agent. For example, recipes with normal amounts of vanilla, almond, chocolate, banana and sour cream are sufficient to maintain a neutral flavor transfer when using the less-refined concentrates as an egg replacement. When formulas are optimized to mimic egg-containing controls, baked goods made with pea protein concentrate have excellent texture; similar color and flavor, and comparable, but slightly softer structure. High-quality results were obtained without the addition of any emulsifiers or crumb enhancers.

MIX WITH WATER, THEN BLEND

Pea protein concentrate mixes well with dry ingredients when dissolved with higher temperature water around 75°C. Food scientists replaced whole/liquid eggs with 25% pea protein concentrate by weight. The concentrate-water mixture has a yellowish-orange, creamy color similar to eggs. Flavor ingredients should be added to this liquid, rather than later in the recipe preparation, and then blended with dry ingredients.

PUTTING PEA PROTEIN THROUGH THE PACES

THE COOKIE TRIAL

Pea protein proved to be a viable alternative for eggs in both sugar snaps and chocolate chip cookies. Based on these results, expect cookies made with pea protein to look like cookies made with eggs, with similar cookie spread and height. Pea protein cookies had greater moistness than cookies made with eggs. In general, cookies made with pea concentrates or pea isolates were similar. Objective measurements on cookies made with pea isolates confirmed lower peak hardness and thus softer textures than cookies made with eggs. Indeed, texture analysis indicates that pea protein has a tenderizing effect. Peak hardness values for cookies made with isolates are 1.89 times harder than the cookies made with eggs.

Despite uniform baking times, chocolate chip cookies made with fresh eggs were darker in color than those made with pea protein isolates, suggesting that Mailliard browning was an issue. The sugar snap cookies used dehydrated eggs in the control and were similar in color across all comparisons.

Affect of protein source on sugar snap-type cookie parameters

protein source	avg. width *(cm)***	avg. height *(cm)***	avg. weight *(g)***	avg. hardness value *(g)****
non-fat dry milk	5.73	1.92	22.2	2550
dried egg	6.03	1.77	21.8	1555
pea protein concentrate*	5.79	1.96	22.2	1308
spray-dried pea isolate*	5.95	2.02	22.0	809
freeze-dried pea isolate	5.80	1.99	22.3	831

** Commercial sources of pea protein concentrate and isolates.*

*** The average values were determined from six cookies according to the AACC International method 10-53.01*

**** The average values were determined from four cookies using a compression test with a trigger load of 10g, deformation of 10mm, and a speed of 5mm/s.*

Above: The sugar snap-type cookie prepared from non-fat dry milk, pea proteins, and eggs. Cookies shown in duplicate. From left to right: non-fat dry milk, pea protein concentrate, freeze-dried pea isolate, spray-dried pea isolate, and eggs.

Left: The chocolate chip cookie prepared from a common household recipe. The formulas contained either egg (left) or pea protein isolate (right).

Dry Spaghetti (100% egg replacement)

Ingredients	*Percent*
Semolina[1]	90
Pea protein concentrate	10
Water hydration	32

[1]12.5% moisture basis

Procedure

Blend dry ingredients using cross ow blender. Mix, hydrate, and extrude blended semolina with a single screw extruder. Upon extrusion, cut pasta dough and dry with ultra-high temperature drying cycle.

Ravioli

Ingredients	*Percent*
Extra Fancy durum flour[1]	90
Pea protein concentrate	10
Water hydration	39

[1]12.5% moisture basis

Procedure

Blend dry ingredients using cross ow blender. Mix, hydrate, and laminate blended durum our with a roller or by using a ravioli machine. Upon lamination, sheet the dough and ll with meat and/or cheese llings. To store the ravioli, toss with our or cornmeal and store at 4° F until further processing.

Nutrition Facts
Serving Size (132g)

Amount Per Serving	
Calories 320	Calories from Fat 10
	% Daily Value*
Total Fat 1g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 66g	**22%**
Dietary Fiber 4g	**16%**
Sugars 2g	
Protein 16g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 20%

*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

Nutrition Facts
Serving Size (139g)

Amount Per Serving	
Calories 320	Calories from Fat 10
	% Daily Value*
Total Fat 1g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 66g	**22%**
Dietary Fiber 4g	**16%**
Sugars 2g	
Protein 16g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 20%

*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

Double Chocolate Cupcake

Ingredients	*Grams*	*Amount (Baker's %)*
Hot brewed coffee	360	88
Baker's chocolate	84	20
Pea protein concentrate	42	10
Water at 75°C	123	30
Vanilla extract	3.0	0.7
All-purpose flour	410	100
Sugar	645	157
Unsweetened cocoa powder	124	30
Baking soda	12.2	3.0
Baking powder	3.1	0.8
Salt	8.6	2.1
Vegetable oil	165	40
Milk	196	48
Sour cream	244	60

Procedure

Mix chopped chocolate with hot coffee. Mix pea protein concentrate with water and vanilla extract. Mix all wet ingredients. Add dry ingredients and mix on medium speed. Fill muf n pans. Bake at 300 F for 20 minutes. Cool completely and spread the cupcake with frosting.

Nutrition Facts
Serving Size (60g)

Amount Per Serving
Calories 160 Calories from Fat 50

	% Daily Value*
Total Fat 6g	**9%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 5mg	**2%**
Sodium 180mg	**8%**
Total Carbohydrate 27g	**9%**
Dietary Fiber 1g	**4%**
Sugars 18g	
Protein 3g	

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

Sunflower Cookie

Ingredients	*Grams*	*Amount (Baker's %)*
Pea protein concentrate	23	12
Water at 75°C	67	34
Vanilla	4.0	2.0
Shortening	89	45
Margarine	114	57
Sugar	215	108
Brown sugar	110	55
All-purpose flour	200	100
Baking soda	6.0	3.0
Salt	3.1	1.6
Oatmeal	90	45
Sunflower seeds	40	20
Chopped butterscotch	60	30

Procedure

Mix pea protein concentrate with water and vanilla extract. Cream pea protein concentrate mixture, with shortening, margarine, and sugars. Add the rest of dry ingredients. Fold in sun ower seeds and butterscotch. Bake at 350 F for 11 minutes.

Nutrition Facts
Serving Size (40g)

Amount Per Serving
Calories 170 Calories from Fat 80

	% Daily Value*
Total Fat 9g	**14%**
Saturated Fat 3g	**15%**
Trans Fat 1g	
Cholesterol 5mg	**2%**
Sodium 160mg	**7%**
Total Carbohydrate 22g	**7%**
Dietary Fiber 1g	**4%**
Sugars 14g	
Protein 2g	

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

Waffle

Ingredients	*Grams*	*Amount (Baker's %)*
Pea protein concentrate	20	6.7
Water at 75°C	42	14
Vanilla extract	4.5	1.5
Almond extract	4.0	1.3
All-purpose flour	300	100
Baking powder	14	4.6
Salt	3.4	1.1
Sugar	57	19
Eggs	111	37
Vegetable Oil	158	53
Milk	461	154

Procedure

Mix pea protein concentrate with water, vanilla extract, and almond extract. Sift dry ingredients. Whisk pea protein concentrate mixture with eggs at high speed. Add oil, milk, and then dry ingredients. Mix well. Pour batter into a non-stick waf emaker. Cook until desired color is obtained at approximately 100-120 C for 4-8 minutes.

Nutrition Facts
Serving Size (73g)

Amount Per Serving
Calories 190 Calories from Fat 100

	% Daily Value*
Total Fat 11g	**17%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 35mg	**12%**
Sodium 200mg	**8%**
Total Carbohydrate 19g	**6%**
Dietary Fiber 0g	**0%**
Sugars 6g	
Protein 4g	

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

Banana Bread

Ingredients	*Grams*	*Amount (Baker's %)*
Pea protein concentrate	28	11
Water at 75°C	84	34
Vanilla extract	6	2.4
Ripe bananas	122	49
Sour cream	112	45
Butter, melted	147	59
All-purpose flour	250	100
Sugar	180	72
Baking soda	5	2.0
Baking powder	4	1.6
Salt	3	1.2
Chopped walnuts	131	52
Semi-sweet chocolate	100	40

Procedure

Mix pea protein concentrate with water and vanilla extract. Puree with banana and sour cream. Sift together dry ingredients. Combine wet and dry ingredients until absorbed. Fold in chopped walnuts and semi sweet-chocolate. Pour the mixture into 2 loaf pans (9 ¼ x 5 ¼ x 2 ½). Bake at 350 F for 60 minutes.

Nutrition Facts
Serving Size (49g)

Amount Per Serving
Calories 180 Calories from Fat 90

	% Daily Value*
Total Fat 10g	**15%**
Saturated Fat 5g	**25%**
Trans Fat 0g	
Cholesterol 15mg	**5%**
Sodium 125mg	**5%**
Total Carbohydrate 20g	**7%**
Dietary Fiber 1g	**4%**
Sugars 11g	
Protein 3g	

Vitamin A 4% • 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

THE REST OF THE STORY

Providing food manufacturers and consumers with a functional egg alternative is just the latest item in a growing list of practical applications for pea protein.

- Gluten-Free
- Protein Supplements
- High-Protein Pastas
- Energy Bars
- Drink Mixes
- Protein-Fortified Baked Goods
- Cereals
- Extruded Snacks
- Smoothies and Shakes
- Pet Foods

ENHANCED PROTEIN QUALITY

Rich in lysine, the high-quality amino acid balance of pea protein makes it a perfect compliment to wheat protein while its uncommon allergen status outshines soy and whey sources. If gluten-free is part of your product portfolio, the creamy-white color and availability of pea protein also eclipses rice protein. What's more, pea adds a pleasant nutty flavor versus the cereal-like flavor of wheat or rice.

STABILITY—IN TRIPLICATE

Emulsion stability.
Pea protein holds on to both fat and water, making a creamy, stable emulsion that offers process stability, holds flavor components together and improves shelf life.

Process stability.
Pea protein won't lose its structure or functionality under high temperatures, pH fluctuations or pressure. Such stability enables high-stress processes such as baking, deep frying and extrusion.

Extrusion stability.
Pea protein can replace gluten as a stabilizer in snacks and cereals, becoming part of a matrix that allows expansion; thereby maintaining desired structure, texture and shape.

PRACTICAL, AFFORDABLE, FUNCTIONAL

Pea Protein creates healthy as well as tasty snacks and nutrition bars with good "bite" and mouth feel. Maintain volume without expansion in bread crumbs and brownies. Include up to 11% pea protein to create high-protein pastas that withstand cooking and deliver traditional texture. Stretch gluten supplies in conventional baked goods because pea protein mimics the bulk and structure of wheat flour. Or, tap into the $7 billion gluten-free market in the U.S. Create gluten-free snacks and cereals with popular shapes and texture by using pea protein in conjunction with a non-cereal starch such as pea starch or tapioca to replace wheat or corn flour. Use pea isolates to make nutritious, 50% reduced-fat salad dressings with the mouth feel, taste and stability of their full-fat counterparts. Dairy-free smoothies also can get a high quality protein boost from pea isolates. And now, reduce market exposure to fluctuating egg costs by using pea protein as an egg replacement in baked goods and pastas.

CONCENTRATED PROTEIN BULLET

Pea isolates are at least 80% protein—packing a powerful protein punch with lots of flexibility for other ingredients. Indeed, as little as 2% to 5% of a pea protein isolate added to wheat flour is enough to hike the nutritional value without major formula changes. Highly refined to reduce oligosaccharides, pea protein isolates offer improved flavor, mouth feel and digestive ease. These attributes allow increased protein levels in foods such as high-fiber, high-protein, low-calorie breads without changing their flavor. Pea protein isolates usually contain little if no starch or fiber. But don't fret about cardboard chewiness. Pea isolates provide their potent protein boost without that mouth-drying woody taste.

ONE SIZE NEEDN'T FIT ALL

Pea protein isolates are commercially available in particle sizes ranging from 150 to 400 microns to fit a variety of applications. Smaller particles sizes are well-suited for beverages, nutrition bars and any application where a smooth mouth feel is desired. Larger particle sizes operate like a molecular sponge—with excellent water retention that reduces cooking loss, improves yield and provides a moist mouth feel. Medium-sized particle sizes are available for applications that require a bit of both attributes.

Pea protein concentrates range from 35% to 60% protein and may or may not have a starch component. Pea protein concentrates are generally larger in particle size than isolates (20 to 30 microns). Still a fine powder, the larger particle size of pea protein concentrates make them well-suited for water-absorbing applications and for enhancing texture in baked goods and pastas.

Remember to store pea protein powders out of light and tightly sealed to maintain neutral flavor. Refrigeration aids in maintaining freshness. For product sources or more information, contact Northern Pulse Growers Association, ***www.northernpulse.com*** or USA Dry Pea & Lentil Council, ***www.pea-lentil.com***

USA Dry Pea & Lentil Council
www.pea-lentil.com

Northern Pulse Growers Association
www.northernpulse.com

Project funded by:
Northern Pulse Growers Association

Final Report

Characteristics and Economic Contribution of the North Dakota Grape Industry

Prepared for:

The North Dakota Grape Growers Associations

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Introduction

North Dakota's first commercial winery opened in 2002. While North Dakota was the last state to have a licensed commercial winery, since 2003 the number of commercial wineries has increased to 9 and numerous commercial and hobby vineyards are located throughout the state. Interest in commercial wine making has increased considerably in North Dakota, but because the commercial grape and wine industry is so new, little is known about the characteristics and nature of the grape and wine sector in North Dakota. Many nearby states have examined the effect of the grape and wine industry on their state's economy (Folwell et al. (1999), MFK (2001), MFK (2007)), however no comprehensive study of the economic impact of the grape and wine industry in North Dakota has been conducted. Accordingly, this study was undertaken to examine the characteristics of grape growers, vineyards and wineries and measure the economic contribution of the North Dakota grape and wine industry.

Methods

The grape and wine industry in North Dakota can be broken down into two activities; grape growing and wine production (Radke (2009)). Commercial entities can engage in either activity or combine the two activities, however in order to produce and sell wine, wineries must apply for an annual manufacturing license with the state of North Dakota. Currently North Dakota has nine licensed wineries. The remaining grape and wine industry entities in North Dakota are vineyards that do not have a commercial winery component. Accordingly, two questionnaires were developed; one for vineyards and one for licensed wineries (Appendix A). The only difference between the two questionnaires was an additional section in the vineyard and winery survey that addressed winery characteristics. A mailing list of North Dakota vineyards and wineries was developed from the membership list of the North Dakota Grape

Growers Association. One hundred and thirty-four operations were identified. The nine licensed wineries received a questionnaire designed to gather information about both the winery and vineyard components of their operations. All others received the vineyard questionnaire. Six questionnaires were either undeliverable or duplicates and 49 were returned for a return rate of 38 percent. Normally a 38 percent response rate would be considered an excellent response and provide a fair degree of confidence in the statistical validity of the sample, however with such a small population (138) the potential margin of error is larger than would be the case with a larger sample.

Results

Results and conclusions are detailed in the following sections. Respondent's additional comments are detailed in Appendix B.

Demographics

Two-thirds of survey respondents indicated they consider their vineyard a hobby operation (Table 1). While one-third or 14 respondents indicated they consider their operation a commercial entity, only 2 respondents (12 percent) indicated their vineyard or winery was the primary source of household income. One of the two commercial entities that indicated the winery was the primary source of household income reported the vineyard or winery represented 50 percent of household income, and the other reported the vineyard or winery represented zero percent of household income (data not shown). Most of the vineyards were also very new operations, 27 percent of respondents have been in existence for a year or less and two-thirds have been operating for four or fewer years (Table 1). Sixty-six percent were either sole proprietorship or partnerships with only 34 percent organized as a LLC or Corporation. Consistent with what would be expected of a hobby enterprise, 91 percent of respondents used

Table 1. Demographic Characteristics, North Dakota Wineries and Vineyards, ND Grape Growers Association Survey, 2010

Type of Operations	----percent----
Hobby	66
Commercial	34
(n)	(41)
Years of Operation	----percent-----
One year or less	27
2 - 4 years	39
4 - 6 years	26
7 - 10 years	10
more than 10 years	8
Average years of operation	4.9
Median	3
Mode	1
(n)	(49)
Primary Source of Household Income	----percent----
Yes	12
No	88
(n)	(17)
Organizational Structure	----percent----
Sole Proprietorship	44
Partnership	22
LLC	17
Corp or Other	17
(n)	(18)
Labor and personnel	-------
Percent that use unpaid family labor	91
Average number of family members	3
Average annual hours	593
(n)	(43)
Percent with paid staff	9
(n)	(43)
Average number of FTE's	1.5
(n)	(4)

an average of 593 hours of unpaid family labor per year. Only 9 percent of respondents indicated they had an average of 1.5 full time equivalent paid staff.

Vineyard Characteristics

The number of vines and the average acreage of vineyard properties also varied considerably. Forty-one percent of respondents reported their vineyard properties were less than 1 acre, while 29 percent had properties that were 1 to 3 acres. Only 15 percent of respondents had vineyard properties of more than 10 acres (Table 2). The average vineyard property was 8.5 acres.

Table 2. Number of Vines and Acreage of Vineyard Properties, North Dakota Grape Growers Association Survey, 2010

Vineyard Acreage	----percent-----
less than one acre	41
1 - 3 acres	29
more than 3 - 10 acres	15
more than 10 acres	15
(n)	(34)
Number of Vines	----percent----
15 or fewer	24
16 - 100	27
101 - 350	24
more than 350	24
(n)	(45)

Average number of vines was 310 vines, with observations ranging from zero to 2,300 vines (Table 3). Responses for the number of vines and vineyard acreage were sufficiently distributed to meet the necessary assumptions to calculate upper and lower mean confidence intervals at 90 percent confidence level. The 90 percent mean confidence interval for the number of vines was between 160 and 460 vines. The 90 percent mean confidence interval for the average vineyard acreage was between 1.2 and 15.7 acres. The wide range of the upper and lower confidence limits demonstrates the substantial variability in responses and the need for caution when interpreting mean results. Like vineyard acreage there was a great deal of variation in the number of vines. About a quarter of respondents had less than 16 and about a quarter had over 350 vines.

Table 3. North Dakota Vineyard Characteristics, North Dakota Grape Growers Association Survey, 2010

Item	Mean	Min	Max	SD[1]	Median	Mode	LCL[2]	UCL[3]
Number of Vines	310	0	2,300	498	100	4	160	460
(n)					(45)			
Vineyard property acreage	8.5	0	85	21	1	.5	1.2	15.7
(n)					(34)			
Average number of additional vines	205	2	1,100	299	65	200	82	329
(n)					(25)			
Average number of additional acres	.81	0	5	1.4	.25	0	--	1.7
(12)					(12)			

[1]Standard deviation, [2]Lower confidence interval level, [3]Upper confidence interval level

While vineyards were generally located on relatively small acreages, nearly two-thirds of respondents indicated they have plans to expand their vineyard in the next year. Planned expansions range in size from the addition of 2 vines to over 1,000 vines (Table 3) with an average planned expansion of 205 vines (data not shown). The mean would suggest quite large expansions are planned, however a few large observations distorted the average. About half of the respondents plan expansions of 65 or fewer vines (data not shown). The 90 percent upper and lower confidence intervals were wide ranging; 82 vines to 329 vines. Vineyard acreage expansions ranged in size from .05 acres to 5 acres, however 75 percent of respondents indicated they planned to expand by less than 1 acre (data not shown). The 90 percent upper confidence limit for acreage expansions was 1.7 acres.

Respondents were also asked to detail how many pounds of grapes and/or grape juice they sold. Only 7 respondents reported selling grapes and only 1 respondent reported selling grape juice. The most frequent response was no response. Normally a non-response is not considered when interpreting results, however considering the large number of hobby vineyards it is likely

that rather than responding “zero” to indicate no sales of grapes or grape juice, respondents simply did not respond. Accordingly, the average pounds of grapes sold per vineyard is likely overstated. Respondents that reported selling grapes sold an average of 280 pounds at an average price of $0.80 per pound. There were only 14 responses to the question on the average number of pounds of grapes sold and only five respondents completed the question requesting average sales price per pound for grapes. There were no responses to the question regarding average price per pound of grape juice. Upper confidence level mean for price of grapes was estimated to be $1.09 per pound and the lower confidence level mean was estimated to be $0.52 (90 percent confidence interval) (Table 4). Confidence intervals for average pounds of grapes sold could not be calculated.

Table 4. North Dakota Vineyard Characteristics, North Dakota Grape Growers Association Survey, 2010

Item	Mean	Min.	Max.	SD[1]	Median	Mode	ULCM[2]	LCLM[3]
Average pounds of grapes sold	280	0	1,889	572	13.5	0	na	na
(n)					(14)			
Average price in $ per pound	.80	.50	1.00	.23	.9	1	.52	1.09
(n)					(5)			
Average number of cases produced from own grapes	58	1	750	179	6	2	--	--
(n)					(17)			

[1]Standard deviation, [2]Lower confidence interval level, [3]Upper confidence interval level

Only 18 respondents (40 percent) indicated producing wine from the grapes they raised (Table 4). Again the range of responses was quite dramatic. Eleven respondents (65 percent) produced less than 10 cases of wine. Only 1 respondent (6 percent) indicated making more than 500 cases of wine from grapes produced on their vineyard. The remaining respondents indicated producing 10 to 60 cases of wine (data not shown). Average production was 58 cases per year

(Table 4), however if the one extreme high observation (750 cases) is eliminated mean production drops to 14 cases.

Sales and Expenditures

A large majority of respondents (76 percent) reported no annual sales and for those that did, average annual sales varied dramatically. Only 24 percent of respondents reported annual sales ranging from $60 to $220,000 (Table 5). Average sales were estimated to be $7,000. The sum of all observations totaled $267,000 with a maximum observation of $220,000. Assuming the average annual sales figure is representative, state-wide total sales for all North Dakota vineyards and wineries was estimated to be $898,000 annually. (Total sales equal average annual sales of $7,000 times survey population of 134.) However, caution should be exercised when interpreting mean values or assuming the sample is representative of the population. Because of the variability in sample observations and the fact that most vineyards and some wineries in North Dakota are hobbies rather than commercial ventures, it is important to recognize the margin of error is quite high and that the mean is likely overstated. At a minimum estimated annual sales could be assumed to be $267,000 (sum of all survey respondents), however the actual figure is likely higher. Alternately, it seems unlikely total sales were greater than $898,000. Respondents reported annual sales were primarily from the sale of grapes (54 percent) and wine (28 percent) (Table 5). Zero sales were reported for grape vines and only 7 percent of annual sales were attributable to gifts, visitor expenditures or special events. Ninety-one percent of sales were to individuals or entities within North Dakota (Table 5). No internet sales were reported.

Table 5. North Dakota Vineyard and Winery Sales, North Dakota Grape Growers Association

		Mean	Min.	Max.	SD[1]	Mode	Median
	percent	----------dollars----------					
Average Annual Sales		7,018	0	220,000	35,771	0	0
Zero	76	--	--	--	--	--	--
less than $1,000	8	--	--	--	--	--	--
$1,000 - $10,000	8	--	--	--	--	--	--
More than $10,000	8	--	--	--	--	--	--
(n)				(38)			
Distribution of annual sales:		----------percent----------					
Wine	--	28	0	98	40	0	0
Grapes	--	54	0	100	52	100	100
Grape Juice	--	9	0	100	30	0	0
Grape Vines	--	0	0	0	0	0	0
Gifts	--	1	0	10	3	1	0
Visitor Expenditures, special events	--	6	0	54	16	5	0
Other	--	1	0	15	4	1	0
(n)				(11)			
		----------percent----------					
Sales made to individuals within ND		91	25	100	23	7	100
(n)				(12)			

[1]Standard deviation

Vineyard Visitation and Special Events

Respondents were queried as to whether or not their vineyard and/or winery had a visitor component. Only 27 percent of respondents indicated they have visitors or held special events at their vineyard (Table 6). The average number of visitors was generally quite small as one-quarter of all respondents had 25 or fewer visitors per year and nearly three-fourths had less than one hundred visitors per year. Average number of visitors was 227, but again a few extreme observations distorted the average. The average number of visitors was based on 11 observations with 38 non-responses. It is likely that many of the non-responses actually represent zero visitors thus overstating the average number of visitors per vineyard. The sum of

Table 6. Vineyard Visitation and Special Events, North Dakota Grape Grower Association Survey, 2010

	------percent-----
Respondents with special events	27
(n)	(44)
Respondents that would like to add visitor component	33
(n)	(30)
Number of Visitors per year	
25 or fewer	27
26 - 100	45
More than 100	27
(n)	(11)
	------number-----
Average number of visitors	227
Median number of visitors	50
Standard Deviation	445
Range	5 - 1,500
Sum	2,498
(n)	(11)
Visitor Residence	------percent-----
Local area	67
Elsewhere in ND	24
Out of State	9
(n)	(15)

all respondents was approximately 2,500 visitors. Two thirds of visitors were from the vineyard's local area, one- fourth were from elsewhere in North Dakota and only 9 percent were from out of state. It is likely more accurate to interpret the results as the average visitation for those respondents with a visitor component rather than generalizing results to the entire population. Only two respondents reported gross sales from visitors. The sum of respondent gross sales was less than $30,000.

Winery Characteristics

Recall that there were only 9 entities that were identified as "wineries" and 4 responded to the questionnaire. All findings in this section on winery characteristics are based on those 4 or fewer observations.

Seventy-five percent of respondents to the vineyard and winery questionnaire indicated they purchase fruit, fruit juice, grapes or grape juice from sources other than their own vineyard (data not shown). Respondents were also asked how many pounds of each were acquired and the price, however respondents simply did not provide responses to the question. There was only one observation to the questions related to winery's purchases of grapes, grape juice, fruit or fruit juice.

Respondents were asked where the fruit, fruit juice, grapes or grape juice used to produce their wine came from. Most of the wine produced was made with grapes or fruit that came from the respondents own vineyard. Respondents indicated that 52 percent of grapes or fruit used to produce wine came from their own vineyard, 31 percent from vineyards elsewhere in North Dakota and only 17 percent from out of state suppliers (Table 7).

Table 7. Winery Characteristics, North Dakota Grape Growers Survey, 2010

	Mean	Min	Max	SD[1]
Fruit or grape juice used to make wine from:	----------percent----------			
Own vineyard	52	0	100	45
Other ND growers	31	0	70	29
Out of state growers	17	0	70	35
(n)		(4)		
Wine Sales:	----------number----------			
Cases sold at winery	50	34	70	45
Cases sold at festivals	7	0	20	29
Total cases sold	58	49	70	11
Gross sales at winery ($)	7,800	5,750	9,252	1,826
Gross sales at festivals ($)	1,180	0	3,360	1,890
Total sales ($)	8,980	8,010	9,432	734
(n)		(3)		
Average price per bottle	----------percent----------			
less than $10	20	0	80	40
$10 to $15 per bottle	70	20	100	36
$16 to $25 per bottle	10	0	31	15
greater than $25 per bottle	0	0	0	0
		(4)		

[1]Standard Deviation

Respondents reported selling an average of fifty eight cases of wine, most of which (50 cases) were sold at their own winery (Table 7). Respondents did not report any retail sales shipped from their winery or any wholesale sales. Average gross sales were $7,800 at the winery location and $1,180 at festivals for average total sales of $8,980. Sum of respondents' total sales was just under $26,000. Most bottles (70 percent) sold for $10 to $15, 20 percent sold for less than $10 and 10 percent sold for $16 to $25. Respondents did not report any sales on bottles priced at more then $25 per bottle. Only one respondent indicated plans to expand wine production next year.

Marketing and Technical Assistance

Respondents were asked if they used various marketing tools and to rate their effectiveness. However because of the preponderance of hobby vineyards, there were very few respondents that indicated they used any of the marketing tools listed on the questionnaire. For each type of marketing tool listed, over 80 percent of respondents indicated they did not use that particular marketing tool. Respondents were asked to rate the various tools on a scale of 1 to 5 with a score of 1 being 'not helpful' and 5 being 'very helpful'. Responses were averaged to calculate a mean score. Of those that indicated they used any of the various marketing tools, 'brochures' and the 'internet' received the highest marks in terms of effectiveness with an average score of 4.2 and 4.0, respectively. Results are not detailed because of limited number of observations. There were four or fewer observations for each of the various marketing tools listed.

Response rates for questions querying respondents about what type of technical assistance would be most helpful were much better than for questions related to marketing tools. The same 5 point scale where 1 is not helpful and 5 is very helpful was used to rate effectiveness and calculate a mean score. Over 70 percent of respondents indicated technical information on

‘grape vine cultivation’, ‘land management and improvement’ and ‘wine making’ would be helpful or very helpful with average score of 4.1, 3.9 and 3.9, respectively (Table 8). About half of respondents indicated the information on ‘marketing/advertising’, ‘web site design and internet applications’, ‘business, financial management and strategic planning’, ‘legal’ and ‘industry trends’ would be helpful or very helpful with average scores of 3.2 to 3.4. Only ‘personnel management/guest relations’ had an average score of less than three with only 28 percent of respondents indicating that type of information would be helpful or very helpful.

Table 8. Type of Technical Information that Would be Most Helpful, North Dakota Grape Growers Survey, 2010

Type of Marketing Information	Mean	Not Helpful	Neutral	Helpful or Very Helpful	LCLM[1]	UCLM[2]
		----------percent----------				
Business, financial management, strategic planning	3.2	27	21	52	2.7	3.8
Marketing, advertising	3.4	21	21	57	2.9	4.0
Legal	3.4	24	21	55	2.8	3.9
Land management and improvement	3.9	18	6	76	3.4	4.4
Grape vine cultivation	4.1	12	12	76	3.7	4.5
Wine making	3.9	12	15	73	3.5	4.4
Personnel management/guest relations	2.9	38	34	28	2.3	3.4
Industry trends	3.1	25	25	50	2.8	3.8
Web site design, internet applications	3.4	30	15	55	2.9	4.0
Other	3.1	44	11	44	1.6	4.6
(n)				(33)		

[1]Lower confidence level mean, [2]Upper confidence level mean, [3]Other: defense against spray by neighboring farms, places to sell grapes, refrigerated transportation to larger markets

Expenditures

Overall expenditures by North Dakota vineyards and wineries were very small. Respondents most frequently reported zero expenditures for most categories. For all expenditure categories except ‘grape growing inputs’ and ‘wine making supplies’ 75 to over 90 percent of respondents (depending on expenditure category) indicated they had zero expenditures (data not

shown). Fewer respondents (58 percent) indicated they had zero expenditures for 'wine making supplies' and only 29 percent had no 'grape growing expenditures'. Expenditures for 'grape growing' averaged about $500 per year and 'wine making supplies' averaged $1,800 per year (Table 9). The sum of all expenditures reported by survey respondents totaled $190,000.

Table 9. North Dakota Winery and Vineyard Expenditures Sales, North Dakota Grape Growers Association

	Mean	Min.	Max.	SD	Median	Sum
	----------dollars----------					
Average Expenditures						
Payroll	1,480	0	41,200	7,393	0	45,900
Worker benefits	129	0	4,013	720	0	4,013
Utilities	185	0	3,600	693	0	5,750
Communications	61	0	1,024	202	0	1,899
Transportation	89	0	2,000	362	0	2,750
Insurance	262	0	3,000	777	0	8,150
Business & Prof Services	23	0	500	96	0	700
Interest	96	0	2,000	396	0	3,000
ND taxes	39	0	700	152	0	1,200
Wine making supplies	553	0	7,000	1,462	0	17,167
Grape growing inputs	1,795	0	18,000	3,730	400	55,671
Other[1]	1,411	0	20,000	4,073	0	43,749
Total	3,876	0	55,209	9,898	150	189,950
(n)			(31)			

[1]Aronia plants, equipment prospective growers, membership education, supplies, drip irrigation, vines, grapes

Because of the high degree of variability and the small sample size, caution should be exercised when interpreting the data. In addition to the high degree of variability there were many non-responses. Respondents that did not reply likely assumed the question was not applicable to their winery or vineyard and rather than entering "zero' to denote their level of expenditures they simply did not respond. Because non-responses are not considered in the estimate of the mean, it is likely that the calculated mean overstates average expenditures. Further, one or two large observations distorted the mean.

Conclusions

Winery and vineyard operations in North Dakota are primarily recently established hobby operations that generate very little economic activity. In-state sales of grape and wine products and expenditures for operational inputs are modest at best. Even under the assumption that the sample is representative and the mean is not overstated, applying total mean expenditures to the population of North Dakota vineyards and wineries would yield average total expenditures for all North Dakota wineries and vineyards of approximately $500,000. The sum of expenditures reported by respondents, $190,000, could represent a minimum level of expenditures, however the true mean is likely higher. Further, the mean expenditures are likely overstated and actual total expenditures were less than $500,000 per year. A reasonable conclusion would be to state total sector expenditures are between $190,000 and $500,000 per year.

Total sales are similarly small. Again assuming the sample is representative estimated total sales would be just under $900,000. Like total expenditures the mean is likely overstated. Recall that average sales were estimated to be $7,000 per operation and one large observation accounted for $220,000 of the $267,000 of the sum of total sales reported by survey respondents. A single observation that accounts for 82 percent of total sales strongly suggests use of mean values be done with extreme caution. Like total expenditures, average total sales are likely higher than the sum of reported sales ($267,000) but less than what would be estimated using the average sales figure derived from respondent data ($900,000). Given the current status of this sector and the highly variable survey data, calculating or placing an economic value on the industry is premature at the time.

The economic contribution of the North Dakota grape and wine industry is consistent with an emerging sector. Considering there are only 9 licensed wineries in the state, all of which have been established in the last 8 years, the results are not unexpected. On a positive note, nearly

two-thirds of respondents plan expansions in both the number of vines and size of their properties. Further about one-third of respondents would like to add a visitor component to their vineyard or winery operation. Respondents also expressed a strong interest in technical assistance related to ‘grape vine cultivation’, ‘wine making’ and ‘land management and improvement’. Clearly there is room for substantial growth in the sector in North Dakota. As the sector grows and expands the economic significance of the sector can be revisited. Findings from this effort will provide an effective baseline with which to measure growth.

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APPENDIX A
Survey Instruments

Vineyard Survey

January, 2010

North Dakota Grape Growers Association
Vineyard Survey

Business Characteristics

1. Including 2009, how many years has this vineyard and/or winery been in operation: _____Years

2. Would you consider your operation to be a commercial vineyard/winery or a hobby vineyard/winery?	
Commercial	**Hobby**
If commercial, please go to question 3.	If hobby, please go to question 5.

3. If commercial, is your vineyard the primary source of household income?	
YES	**NO**
If yes, what percent of household income does the winery and vineyard provide?_____%	If no, what percent of household income does the winery and vineyard provide?_____%

4. If commercial, what best describes the organizational structure of your operation? (Please select one.)	
sole proprietorship	_____
partnership	_____
LLC	_____
corporation	_____
franchise	_____
other (please specify)	_____

Sales and Expenditures

5. What were your total annual sales for 2009? $_____

If total annual sales were zero, go to question 10.

What percentage of total annual sales were attributed to winery sales _____%

vineyard sales _____%

6. What percentage of total annual sales were for each of the following:	
Wine Sales	_____%
Grapes	_____%
Grape juice	_____%
Grape vines	_____%
Gifts	_____%
Visitors expenditures, special events	_____%
Other (specify)_____	_____%
Total	100 %

7. What percentage of total vineyard and winery sales were made to individuals or entities:	
within the state	_____%
outside the state	_____%
Total	100 %

8. Do you make internet sales?	
YES	**NO**
If yes, what percentage of total sales are made via internet? _____%	

9. Are there constraints for out-of -state sales, that is do you have trouble selling out of state?	
YES	**NO**
If yes, what are the constraints? _____	

10. What were your total vineyard expenditures for each of the following in 2009 and what percentage of each expenditure category was made to entities in North Dakota?

Example:	Expenditure	%
ND Widgets	10,000 $	80 %

Payroll	Expenditure	% ND
Worker benefits	_____$	_____%
Utilities	_____$	_____%
Communications	_____$	_____%
Transportation	_____$	_____%
Insurance	_____$	_____%
Business & professional services	_____$	_____%
Interest payments	_____$	_____%
North Dakota taxes	_____$	_____%
Wine making supplies & inputs	_____$	_____%
(crusher-destemer, bottles, labels,)	_____$	_____%
Grape Growing Inputs (trellis, growtubes, cable fertilizer, pesticides, etc)	_____$	_____%
Other (please specify): _____	_____$	_____%

11. Does your vineyard use unpaid family labor?

YES	**NO**

If yes, on average how many hours per year for all family members combined? _____
How many family members? _____

12. Does your vineyard have paid employees?

YES	**NO**
If yes, how many FTEs_____	

Vineyard Characteristics

13. Vineyard information:	
How many vines do you have?	_____vines
What is the total acreage of your vineyard property?	_____acres

14. How many pounds of each of the following did you sell in 2009 and what was the average price per pound?		
Grapes	_____ pounds	$_____per pound
Grape juice	_____ pounds	$_____per pound

15. Do you plan to expand your vineyard in the next year?	
YES	**NO**
If yes, how many additional vines _____	
If yes, how many additional acres _____	

16. Did you produce wine from the grapes produced in your vineyard?	
YES	**NO**
If yes, how many cases of wine did you produce? _____	

Vineyard Visitation

17. Do you have visitors or host special events at your vineyard?		
YES	**NO**	
If yes, approximately how many people visited your vineyard in the last year?_____	If no, would you like to add a visitor/special event component to your vineyard?	
	YES	**NO**
	If no, please go to question 23.	

18. Approximately what percentage of your visitors are from each of the following:	
the local area	_____%
elsewhere in North Dakota	_____%
out of state	_____%
Total	_____100 %

19. Would you like to increase the number of visitors to your vineyard?	
YES	**NO**
If yes, what do you plan to do increase the number of visitors to your vineyard? (specify) _____ _____	

20. Would you like to increase the number of visitors to or special events held at your vineyard?	
YES	**NO**
If yes, by how many? _____	

21. What percentages of your visitors in 2009 fall into the following categories (N/A if a category does not apply to your vineyard)?	
Winery visitors	_____%
Special event visitors	_____%
Gift shop visitors	_____%
Restaurant visitors	_____%
Other (describe_____)	_____%
Total	_____%

22. What was your gross revenue from visitor sales in 2009? _____

Marketing and Technical Assistance

23. How do you market your vineyard? Please rate each type of advertising that you use on a scale of 1 to 5 with 1 being *not effective* and 5 being *very effective*.

	Please Circle One		**Not Effective**		**Neutral**		**Very Effective**	**N/A Hobby Vineyard**
Brochures	YES	NO	1	2	3	4	5	6
Printed media (newspapers/magazine)	YES	NO	1	2	3	4	5	6
Radio	YES	NO	1	2	3	4	5	6
Television	YES	NO	1	2	3	4	5	6
Travel Guides	YES	NO	1	2	3	4	5	6
Internet	YES	NO	1	2	3	4	5	6
Other (specify)_____	YES	NO	1	2	3	4	5	6

24. What type of information or technical assistance would be helpful to you? Please rate each item on scale of 1 to 5 with 1 being *not helpful* and 5 being *very helpful*.

	Not Helpful		Neutral		Very Helpful
Business and/or financial management; strategic planning	1	2	3	4	5
Marketing/advertising	1	2	3	4	5
Legal (insurance, liability, contracts, state/local regulations)	1	2	3	4	5
Land management and improvement	1	2	3	4	5
Grape vine cultivation	1	2	3	4	5
Wine making	1	2	**3**	**4**	**5**
Personnel management/guest relations	1	2	3	4	5
Industry trends and updates	1	2	3	4	5
Web site design, internet applications	1	2	3	4	5
Other (Please specify.)_____	1	2	3	4	5

Next Page ➡

Additional Comments

Please feel free to offer any additional thoughts or comments. This is your opportunity to address any issues not covered in this questionnaire. Your response is important and will be kept strictly confidential.
Additional comments:

Please return the questionnaire in the enclosed postpaid envelope.

If you have any questions you may contact Larry Leistritz at 701-231-7455 or Nancy Hodur at 701-231-7357.

For a copy of the study results, please provide your name and mailing address below or contact the Department of Agribusiness and Applied Economics at North Dakota State University, Fargo, ND, phone 701-231-7442, FAX 701-231-7400 or email: nancy.hodur@ndsu.edu or visit our departmental listing of research reports on the web at http://ageconsearch.umn.edu/.

Name: _____

Address: _____

City, State, Zip: _____

Thank you for taking the time to fill out the questionnaire. Your cooperation is sincerely appreciated.

Winery & Vineyard Survey

January, 2010

Winery Characteristics

23. Did your winery acquire fruit, fruit juice, grapes or grape juice from sources other than your own vineyard for wine production in 2009?

YES	NO

If yes, how much of each did you acquire and at what average price?

____ pounds of fruit $_____average price per pound
____ pounds of fruit juice $_____average price per pound
____ pounds of grapes $_____average price per pound
____ pounds of grape juice $_____average price per pound

24. In 2009 what percentage of fruit, fruit juice, grapes or grape juice that were used to produce wine came from each of the following:

own vineyard	_____%
other North Dakota growers	_____%
out of state growers	_____%
Total	100 %

25. In 2009 how many cases of wine were sold through your winery in the past year, and what were the dollar sales in each category?

Sold at winery	_____ # of cases	Sales $_____
Sold at festivals	_____ # of cases	Sales $_____
Retail sales shipped from winery	_____ # of cases	Sales $_____
Wholesale sales (liquor store, restaurants, wineries)	_____ # of cases	Sales $_____
Other (please specify) _____	_____ # of cases	Sales $_____
Total wine sales by your winery	_____ # of cases	Sales $_____

26. In 2009 what percentage of your retail wine sales were in each of the following price ranges? If no retail sales, check here and go to question 27_____	
Less than $10 per bottle	_____ %
$10-15 per bottle	_____ %
$16-25 per bottle	_____ %
More than $25 per bottle	_____ %
Total	_100_ %

27. Do you plan to expand wine production next year?	
YES	**NO**
If yes, by how much? _____%	
If yes, how much of the expansion will come from**:**	
Other vineyard _____%	
Own vineyard _____%	
Total ____100%	

Marketing and Technical Assistance

28. How do you market your vineyard? Please rate each type of advertising that you use on a scale of 1 to 5 with 1 being *not effective* and 5 being *very effective*.

	Please Circle One		Not Effective		Neutral		Very Effective
Brochures	YES	NO	1	2	3	4	5
Printed media (newspapers/magazine)	YES	NO	1	2	3	4	5
Radio	YES	NO	1	2	3	4	5
Television	YES	NO	1	2	3	4	5
Travel Guides	YES	NO	1	2	3	4	5
Internet	YES	NO	1	2	3	4	5
Other **(**specify)_____	YES	NO	1	2	3	4	5

29. What type of information or technical assistance would be helpful to you? Please rate each item on scale of 1 to 5 with 1 being *not helpful* and 5 being *very helpful*.					
	Not Helpful		Neutral		Very Helpful
Business and/or financial management; strategic planning	1	2	3	4	5
Marketing/advertising	1	2	3	4	5
Legal (insurance, liability, contracts, state/local regulations)	1	2	3	4	5
Land management and improvement	1	2	3	4	5
Grape vine cultivation	1	2	3	4	5
Wine making	1	2	3	4	5
Personnel management/guest relations	1	2	3	4	5
Industry trends and updates	1	2	3	4	5
Web site design, Internet applications	1	2	3	4	5
Other (Please specify.)_____	1	2	3	4	5

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