USDA Specialty Crop Grant Report

North Dakota Department of Agriculture

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Project 1
(Subcontract 09-137)
Northern Pulse Growers Association

Project Title: Improving market access characteristics of pulse crops

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Project 2
(Sub-contract 09-142)
North Dakota State University
Carrington Research Extension Center and Department of Animal Sciences

Project Title: Does the inclusion of field pea components in beef finishing diets influence beef palatability attributes of multiple muscles in cattle genetically indexing for poor carcass parameters?

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Project 3
(Sub-contract 09-136)
National Sunflower Association

Project Title: Introduction of Rust Resistance Genes into Confectionery Sunflower

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Project 4
(Sub-contract 09-135)
Northarvest Bean Growers Association

Project title: Strengthening Value-Added Programs for Dry Edible Beans

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Project 5
North Dakota Department of Agriculture

Title: Going Local North Dakota

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Project 6
Sub-contract 09-138
Northern Plains Potato Growers Association

Project Title
Managing Potato Early Die Through Potato Breeding Efforts

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Project 7
Sub-Contract 09-139
North Dakota State University

Project Title: Evaluation of Hardy Roses for Cut Flower Production

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Project 8
Sub-Contract 09-141
North Dakota Farmers Market and Growers Association

Project Title: Expanding North Dakota Farmers Markets

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Project 9
Sub-contract 09-140
North Dakota Grape Growers' Association

Project title: Creation of wine grape hybrids for North Dakota

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NORTHERN PULSE GROWERS ASSOCIATION
USDA SPECIALTY CROP BLOCK GRANT

FINAL REPORT

A. Project Title: Improving the market access characteristics of pulses grown in North Dakota, Montana and South Dakota

B. Project Summary: Pulses have become significant crops for the region's agriculture industry and are primarily grown in rotation with cereal and oilseed crops. Regional growers have been rotating pulses to provide a break in disease cycles and improve soil nitrogen. In the last 10 years pulse exports significantly increased however we have observed steady growth in the domestic market and recent interest has been reported by the food service industry. Thus the domestic market development activities were identified as the integral part of this project due to the growing interest. In the last three years the Northern Pulse Growers Association (NPGA) worked with the Northern Crops Institute (NCI) to develop technical quality specifications for pulses. Physical, chemical and cooking properties of major pea cultivars grown in the tri-states were evaluated. In addition, dry peas were processed into split peas, pea flour, starch-rich pea flour and protein-rich pea flour ingredients. Technical specifications for dry yellow and green pea and pre-cooked pea flours were developed. However the present information was not sufficient to conduct extensive outreach programs for the food service industry to be utilized by medical doctors, dietitians, teachers, research chefs, food service buyers and other end users. Thus the NPGA has partnered with the NCI to improve the market access programs of pulses, which was complimented with previous support of the USDA Specialty Crop Block Grant Program. In this project we developed new pulse based food service products, established a food service industry guide, developed a health & nutrition brochure, participated in several food trade shows and prepared public relations materials in order to improve the market development for the regional grown pulses.

C. Project Approach: Project was conducted by NPGA staff, NCI staff and North Dakota State University Department of Cereal Science and Department of Nutrition and Exercise Sciences faculty.

C.1.Ingredient Quality Evaluation: NCI Crop Quality Specialist, Thunyaporn Jeradechachai and NCI Technical Director, Dr. Mehmet Tulbek evaluated and established the ingredient quality of pea, lentil and chickpea crops grown in North Dakota, Montana and South Dakota (printed survey enclosed in the package). This segment of the project assisted the pulse industry in establishing ingredient quality and in addition helped determine food safety standards of the pulses.

C.2.Food Service Product Industry Guide: NCI Crop Quality Specialist, Thunyaporn Jeradechachai and NCI Technical Director, Dr. Mehmet Tulbek developed several pea, lentil and chickpea based food products and established recipes. These recipes were printed in the Food Service Industry Guide (printed copy enclosed in the package) which was developed by NPGA. This booklet is being used as a standard tool for product development in the industry. The information presented in the

package demonstrates the impact of pea, lentil and chickpea flour in food systems. In addition, the report discusses the enhancement in protein and dietary fiber levels of pulse fortified foods.

C.3.Sensory Evaluation of Food Service Products: In this segment of the project NDSU Assistant Professor of Food Science, Dr. Clifford Hall conducted a sensory evaluation project (printed copy enclosed) to determine the impact of pea, lentil and chickpea flour in food products. The acceptance of these products was tested in a thorough consumer acceptance test. The data indicated that pea, lentil and chickpea flour had no impact on the acceptance of consumers.

C.4. Health and Nutrition Booklet: This booklet (printed copy enclosed in the package) was developed by NDSU Associate Professor and Food and Nutrition Specialist, Dr. Julie Garden Robinson in cooperation with NPGA staff. This booklet is the first outreach report which conveys the impact of pulses on human health. It covers the availability of macronutrients and micronutrients in pulse crops and lays the groundwork for the product developers in the food industry. The booklet was distributed by the NDSU Extension Service to ND county agents. In addition, Dr. Robinson developed an outreach presentation for the industry and consumers which will be reached via NDSU, Montana State University and NPGA public web sites.

C.5. Food Trade Shows and Public Relations Materials: NPGA Marketing Director, Kaye Effertz participated in several food trade events including Supply Side East and IFT Minnesota Trade Shows (trade show reports enclosed in the package). These trade shows were used as showcases to demonstrate the work generated in the project and served as outreach to the food industry. In addition, NPGA released a press release on the activities which helped increase awareness of pulses.

D. Goals and Outcomes Achieved:

D.1. To develop new pulse based food products which will be targeted for the U.S. food service sector: The NPGA worked with NCI and NDSU to develop 13 pulse based recipes, a food industry guide, ingredient specifications and food safety guidelines for pulses which helped the tri-state pulse industry. Major outcomes of this goal was to establish the groundwork for key food processing companies and develop the materials to assist them in using pulses and pulse ingredients in main stream products. The products developed in this project presented a wide range of profiles which will help the industry to use more pulses. In addition, we demonstrated the increased protein and dietary fiber levels of pulse based formulas which will get significant attention by the US food service sector.

D.2. To increase awareness of pulse crops and develop health and nutrition based market development materials for the U.S. functional food industry: The NPGA worked with NCI and NDSU on these project goals. Dr. Julie Garden Robinson provided health and nutrition information and developed outreach materials for the regional pulse growers and processors during the project

timeline. NPGA and NCI worked with two national companies to develop new pulse ingredients for utilization in the global marketplace.

D.3. To conduct market development activities by participating in trade shows and public relations programs which will increase pulse awareness in the food service industry: The NPGA worked with NCI to fulfill these project goals. We significantly increased pulse awareness in the food industry. This was validated by a major food processing company representative. In 2010 the new pulse based products released to the US marketplace significantly increased compared to 2009. In addition, five processing companies in the United States started processing pulses into flour and other ingredient forms increasing the value of the crop in the tri-state area.

E. Expected Measurable Outcomes:

1- This project helped improve the market access characteristics of the pulse processing industry in North Dakota, Montana and South Dakota by increasing awareness, increasing domestic pulse consumption, increasing pulse processing capacity primarily in the state of North Dakota and creating additional jobs. Stabilized pea and lentil ingredients are currently being marketed in food service due in part to this project **(This outcome has started and is currently ongoing).**

There is an increased interest in processing pulse flours and fractioned pea protein and starch derivatives in the United States. It is evident by the growing list of U.S. companies that are adding pulse products to their milling operations (see attachment). This list is put together nationally by the USA Dry Pea & Lentil Council (DPLC) and the Northern Pulse Growers Association (NPGA) and is promoted at all DPLC and NPGA events. Companies included on this list are established through contacts made during national food trade shows and other marketing events.

In addition to the list of companies milling pulse products there is a growing list of processing companies looking at using pulses as ingredients in new product development. This was apparent through the amount of interest generated at national food trade shows and a product development course at the Culinary Institute of America. Some new products introduced in the United States include Mars Foodservice - Uncle Bens Whole Grain Medley, Pulfoods Inc. - Crunchfuls Breakfast Cereal, Mary's Gone Crackers – Love Cookies, The Good Bean and Simplot – Upsides.

2- Pulse awareness and market development activities, as well as trade shows and public relations initiatives helped increase the production of peas and lentils. In 2010 the region produced a record lentil crop which was due to the interest in pulse crops. . Lentil acres increased from 280,000 acres in 2009 to 499,000 acres in 2010. The region now accounts for 79% of the lentil production in the United States. The increase in lentil production in addition to quality problems occurring in Canada contributed to a high-end product in the pulse industry. In terms of ingredient markets the original level of pulse costs in 2009 was in a range of 16-31¢/lb. Current

market prices for pulse costs in 2010 has increased to 20-42 ¢/lb. In our original goal, we anticipated that pulse products will be marketed in a range of 40-55¢/lb. However, currently we observed that pulse products are being marketed in a range of 65-90 ¢/lb. **(This outcome has started and is currently ongoing).**

F. Beneficiaries: The primary beneficiaries of this project will be the region's pulse farmers involved in growing dry pea, lentil and chickpea crops. These crops represent $400 million in direct and indirect farm income with the additional benefits of increased yield and the limited use of fertilizer in rotations. Our efforts expanded pulse acres and created higher market prices. As we expand the domestic food service markets within this project new opportunities for the industry and producers to diversify the marketing of pulse crops will be created. This would increase the value of the crop which would go back to the producer. By the end of 2010 the average price for yellow peas was $8.00 per bushel and lentils were priced approximately $27.00 per CWT. In addition, the development of the food service market helped create new opportunities for the expansion of value added companies in this region. As we pointed out in Goal 3, there are five companies processing pulses to flour and other ingredient forms in the United States. We present the list of the companies below in the report (Suppliers of legume flours, powders, flakes, proteins and fibers) for further requests. It is our estimation that each company created minimum two jobs each in the region enhancing the overall economy by creating $80,000 per job including the benefits for the employee. As an average the outcome of the project assisted creating 10 jobs in the region which created $800,000 to the national economy as well as increased the value of pulse crops.

G. Lessons Learned: In this project we observed the positive impact of pulses in food service products and clearly did not observe differences in pulse fortified foods based on consumer acceptance. Pulse based recipes clearly indicated higher protein and dietary fiber levels as well excellent texture. We believe that the product is still not known among the significant portion of main stream consumers. Thus further market development work and additional pulse awareness projects have to be implemented in the future.

H. Contact Information:

Any questions regarding this grant should be directed to:

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SUPPLIERS OF LEGUME FLOURS, POWDERS, FLAKES, PROTEINS, FIBERS

ADM	Box 1470 Decatur, IL 62525 800-637-5843; 217-451-2849 www.adm.com/ediblebeans	Whole/Pieces/Grits/Powder chickpea (garbanzo)
DAKOTA DRY BEAN, INC.	2392 Star Avenue South Grand Forks, ND 58201 www.dakotadrybean.com 1-866-DRY-PEAS / 1-701-398-3112	Flours: pea Fiber: pea Starch pea Protein pea
GEORGE F. BROCKE & SONS	P.O. Box 159 Kendrick ID 83537-0159 Tel: (208) 289-4231	Flours: pea
HARVEST INNOVATIONS	1210 North 14th St. Indianola IA 50125 www.harvest-innovations.com 515-962-5063	Flours: pea lentil chickpea (garbanzo)
INLAND EMPIRE FOODS, INC.	5425 Wilson St. Riverside CA 92509-2434 www.inlandempirefoods.com 951-682-8222	Flours/Powders/Flakes/Grits: green pea yellow pea lentil
NORBEN COMPANY	P.O. Box 766 Willoughby, OH 44096 www.norbencompany.com 440-951-2715 / 888-4-NORBEN	Pea Protein Isolate Functional and Dietary Fiber Low Fat Shortening Replacement Native and Modified Pea Starch Pea Flours and Special Blends
SK FOOD INTERNATIONAL	4666 Amber Valley Parkway Fargo, ND 58104 skfood@skfood.com 701-356-4106	Flours/Powders/Flakes: green pea yellow pea lentil
UNITED PULSE TRADING	1611 E. Century Ave. Suite 102 Bismarck, ND 58503-0780 Phone: 701-751-1623 Fax: (701) 751-1626	Flours/Powders: yellow pea lentil fiber
WOODLAND FOODS, INC.	2011 Swanson Court Gurnee, IL 60031 www.woodlandfoods.com 847-625-8600	Flour: chickpea (garbanzo) Powders: green pea yellow pea

Value-Added Products

MARS
foodservice

ORGANIC
MARY'S Gone CRACKERS
love Cookies
Traditional flavors, Revolutionary ingredients.

Simplot
UpSides
savory side dishes

NORTHERN PULSE GROWERS ASSOCIATION
USDA SPECIALTY CROP BLOCK GRANT
SENSORY EVALUATION REPORT

Table 1. Sensory evaluation data

Product	Average Panelist Score		Variance		Significance
	Pea	Control	Pea	Control	P-value
Ice cream Trial #1	7.1	7.7	1.88	0.96	0.12
Ice cream Trial #2	7	7.5	2.86	2.53	0.33
Ice cream Trial #3	7.9	8.2	0.36	1.91	0.47
Trail Mix	7	7	1.68	0.79	0.89
Pie Crust (cherry pie)	7.3	7.2	0.33	2.49	0.8
Side Dish	6.8	6.9	2.8	2.23	0.81
Pulse Fries	7.5	7.5	1.35	0.88	1
Italian Salad	7.2	7.4	2.49	1.94	0.8
Pizza	7.3	7.6	1.77	1.43	0.42
Mashed Potato	7.5	7.6	1.6	0.59	0.71
Rice Pilaf	4.8	5.1	4.9	3.9	0.71
Pasta	6.9	8.1	2.24	0.74	0.02*
Breadsticks	7.6	7.4	0.55	1.8	0.61

***Denotes significant differences**

- All pea fortified formulas other than pasta had no significant differences with control formulas in terms of consumer acceptance.
- Pea fortified breadstick formula had higher scores than control sample.
- Pea fortified pasta showed statistically significant results compared to control sample.

Table 2. Sensory evaluation form

Score	Descriptor
9	like extremely
8	like very much
7	like moderately
6	like slightly
5	neither like or dislike
4	dislike slightly
3	dislike moderately
2	dislike very much
1	dislike extremely

Pulse Formulas

1. Pizza crust
2. Bread sticks
3. Cracker
4. Ice cream
5. Pie crust
6. Pulse burger
7. Pulse fries
8. Salad
9. Trail mix
10. Side dish
11. Pasta
12. Mashed potatoes
13. Rice pilaf

1. Pizza Crust

Ingredients	Gram	Baker's%
High gluten flour (15% protein)	700	100
Precooked pea flour	115	16
Instant Yeast	7.0	1
White granulated sugar	36	5
Vital wheat gluten	21	3
Salt	11	2
Italian Seasoning	1.3	0
Water (variable)	597	85
Shortening	14	2

Procedures:

Mix the dough. Ferment for 1 hour at 95% R.H., 95°F.
Scale to 345g, round, flour, and rest 15 mins.
Sheet the crust, dock top, and put on sauce and toppings.
Bake at 390°F for 20 mins on pizza pan.

Nutrition Facts

Serving Size (94g)
Servings Per Container

Amount Per Serving	
Calories 210	Calories from Fat 15
	% Daily Value*
Total Fat 1.5g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 270mg	**11%**
Total Carbohydrate 38g	**13%**
Dietary Fiber 3g	**12%**
Sugars 3g	
Protein 10g	

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

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

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

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

Bread Sticks

Ingredients	Gram	Baker's%
High gluten flour (15% protein)	**700**	100
Precooked Pea flour	**115**	16
Vital wheat gluten	**21**	3
Instant yeast	**7.0**	1
White granulated sugar	**36**	5
Salt	**11**	2
Shortening	**14**	2
Italian Seasoning	**1.3**	0
Water (variable)	**597**	85
Monterrey Jack cheese	**200**	29

Procedures:
Mix the dough. Ferment for 1 hour 95%RH, 95°F.
Scale to 100g long sticks.
Proof for 30-40 mins in a fermentation cabinet at 95°F, 95% RH.
Top with cheese and bake at 390°F for 20 mins.

Nutrition Facts
Serving Size (106g)
Servings Per Container

Amount Per Serving

Calories 250 Calories from Fat 50

	% Daily Value*
Total Fat 6g	**9**%
Saturated Fat 2.5g	**13**%
Trans Fat 0g	
Cholesterol 15mg	**5**%
Sodium 360mg	**15**%
Total Carbohydrate 38g	**13**%
Dietary Fiber 3g	**12**%
Sugars 3g	
Protein 12g	

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

2. Cracker

Ingredients	Gram	Gluten free flours Base (%)
Precooked pea flour	73	13
Precooked chickpea flour	73	13
Brown rice flour	125	22
Potato starch	121	21
Tapioca flour	172	30
Extra sharp cheddar cheese	80	14
Monterrey Jack cheese	80	14
Xanthan gum	6.4	1.1
Shortening	70	12
Salt	7.8	1.4
White granulated sugar	5.5	1.0
Baking powder	4	0.7
High fructose corn syrup	19.4	3.4
Garlic powder	2.5	0.4

Procedures:

Mix dry. Cut shortening into dry.

Flatten the mixture to 2mm thickness on a baking sheet.

Bake for 8-10 mins at 400F, cut to shape and bake for another 6-8 mins.

Nutrition Facts

Serving Size (40g)
Servings Per Container

Amount Per Serving	
Calories 150	Calories from Fat 50
	% Daily Value*
Total Fat 6g	**9%**
Saturated Fat 2.5g	**13%**
Trans Fat 0.5g	
Cholesterol 10mg	**3%**
Sodium 220mg	**9%**
Total Carbohydrate 22g	**7%**
Dietary Fiber 2g	**8%**
Sugars 1g	
Protein 4g	

Vitamin A 2% • Vitamin C 0%
Calcium 6% • Iron 4%

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

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

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

3. Low Fat Chocolate Ice Cream

Ingredients	Gram	Milk Base (%)
Whole milk	770	100
Non-fat dry milk	50	6.5
Sugar	130	17
High fructose corn syrup	45	5.8
Vanilla	10	1.3
cocoa	34	4.4
Semisweet chocolate chips	80	10.4
Pea starch isolate	8.5	1.1
Water	44	5.7

Procedures:

Dissolve pea starch in water.
Blend all liquid and dry ingredients.
Batch pasteurize (70C for 30 mins), homogenize, and cool the mixture.
Freeze the ice cream mixture.
Package and harden the ice cream in a blast freezer at -30°C.

Nutrition Facts

Serving Size (113g)
Servings Per Container

Amount Per Serving

Calories 180 Calories from Fat 45

	% Daily Value*
Total Fat 5g	**8%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 10mg	**3%**
Sodium 60mg	**3%**
Total Carbohydrate 30g	**10%**
Dietary Fiber 1g	**4%**
Sugars 25g	
Protein 6g	

Vitamin A 4% • Vitamin C 0%
Calcium 15% • 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

4. Pie Crust

Ingredients	Gram	Baker's %
All purpose flour	450	100
Shortening	270	60
Salt	7	1.6
Egg	50	11
Distilled white vinegar	12	2.7
Water	65	14
Precooked pea flour	40	9

Procedures:

Mix flour and salt. Cut shortening into the flour.
Mix together egg, vinegar and water. Combine all ingredients.
Roll the dough between nonstick surface.
Place the sheeted dough on a pie pan. Fill in the filling.
Bake at 450°F for 10 mins. Bake at 350°F for 45 mins.

Nutrition Facts

Serving Size (112g)
Servings Per Container

Amount Per Serving

Calories 510 Calories from Fat 300

	% Daily Value*
Total Fat 34g	**52%**
Saturated Fat 8g	**40%**
Trans Fat 11g	
Cholesterol 25mg	**8%**
Sodium 350mg	**15%**
Total Carbohydrate 45g	**15%**
Dietary Fiber 2g	**8%**
Sugars 2g	
Protein 8g	

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

*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

5. Pulse Burger

Ingredients	Gram
Cooked split yellow peas	370
Cooked red lentil	100
Cooked split green peas	100
Cooked black bean	200
Tapioca flour	30.6
Xanthan gum	0.9
Pea protein concentrate	10
Vital wheat gluten	20
Olive oil	20
Cumin powder	0.5
Garlic powder	1
Sea salt	3
Sugar	20
Steak seasoning	7.8
Italian seasoning	1.9
Cider vinegar	1.7
Chopped Yellow onion	130
Corn starch	10

Procedures:

Cook pulse by soaking them for at least 30 mins. Boil them in water until they are thoroughly cooked. Completely drain the water. Heat and mix all the ingredients.

Run the mixture through a meat grinder.

Add corn starch. Mix. Add onions and form thin patties.

Fry them with oil on a skillet until golden brown on both sides.

Nutrition Facts

Serving Size (71g)
Servings Per Container

Amount Per Serving	
Calories 110	Calories from Fat 15
	% Daily Value*
Total Fat 1.5g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 180mg	**8%**
Total Carbohydrate 18g	**6%**
Dietary Fiber 4g	**16%**
Sugars 3g	
Protein 7g	

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

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

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

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

6. Pulse Fries

Ingredients	Gram
Cooked red lentils	145
Cooked yellow peas	150
Dried onion	6.2
Salt seasoning	14
Dried parsley	0.18
All purpose flour	60
Sugar	10
Corn starch	15
Water	8

Procedures:
Combine all ingredients in a food processor.
Sheet and cut the dough into desired shape. Blast freeze the fries.
Fry the fries at 180°C for 1-2 mins or until golden brown.

Nutrition Facts
Serving Size (71g)
Servings Per Container

Amount Per Serving

Calories 110 Calories from Fat 0

	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 770mg	**32%**
Total Carbohydrate 23g	**8%**
Dietary Fiber 5g	**20%**
Sugars 4g	
Protein 6g	

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

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

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

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

7. Roasted Lentils Pesto, Tomato, and Mozzarella Salad

Ingredients	Gram
Pesto sauce	
Fresh basil leaves	134
Grated parmesan cheese	11
Extra virgin olive oil	21
Roasted red lentil	16
Chopped garlic	1.9
Lemon juice	2.8
Red wine vinegar	3.3
Salad	
Cherry tomato	527
Mozzarella cheese	78
Cooked chickpea	75
Thinly chopped red onion	5
Pesto sauce	190
Roasted red lentil	75

Procedures:

To roast lentil: Soak for 1 hour. Drain water. Spread thinly and evenly on a sprayed baking sheet. Roast at 360°F for 18 mins.To make pesto sauce: Combine all pesto ingredients in a food processor.To make salad: Cut and lay tomato, mozzarella cheese, and chickpea on a plate. Add pesto sauce on top. Sprinkle with red onion and roasted lentil.

Nutrition Facts

Serving Size (238g)
Servings Per Container

Amount Per Serving

Calories 250 Calories from Fat 100

	% Daily Value*
Total Fat 12g	**18**%
Saturated Fat 4g	**20**%
Trans Fat 0g	
Cholesterol 20mg	**7**%
Sodium 65mg	**3**%
Total Carbohydrate 23g	**8**%
Dietary Fiber 6g	**24**%
Sugars 4g	
Protein 13g	

Vitamin A 60% • Vitamin C 40%
Calcium 15% • Iron 15%

*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

8. Trail Mix

Ingredients	Gram
Red lentils	60
Split yellow peas	60
Split green peas	60
Roasted Sunflower seeds	60
Sweetened dried cranberries	60
Semisweet chocolate chips	74
Olive oil	5
Sea salt	4

Roasting pulses:
To roast peas: Soak 1 hour. Cook for 30 mins and bake for 15 mins at 360°F.
To roast lentil: Soak 1 hour. Drain water. Roast at 360°F for 18 mins.
Procedures:
Roast pea and lentil
Combine roasted lentil, peas, sunflower seeds, mixed berry, and semisweet chocolate chips.
Sprinkle olive oil and sea salt. Mix well and serve.

Nutrition Facts
Serving Size (38g)
Servings Per Container

Amount Per Serving

Calories 160 Calories from Fat 50

	% Daily Value*
Total Fat 6g	**9%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 22g	**7%**
Dietary Fiber 2g	**8%**
Sugars 10g	
Protein 6g	

Vitamin A 0% • 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

9. Side Dish

Ingredients	Gram
Green bell pepper	175
Red bell pepper	175
Orange bell pepper	100
Yellow bell pepper	50
Olive oil	40
Chopped white onion	225
Ground Thyme	1
Ground Cumin	1.4
Ground Black pepper	1
Salt	6
Sugar	3.1
Garlic	0.8
Cooked green lentil	275
Fresh spinach	175

Procedures:

Cook onion in olive oil at medium temperature.
Add pepper, cook until very soft.
Add cooked lentil and other spices.
Add spinach. Mix well and serve.

Nutrition Facts

Serving Size (123g)
Servings Per Container

Amount Per Serving

Calories 220 Calories from Fat 100

	% Daily Value*
Total Fat 11g	**17%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 270mg	**11%**
Total Carbohydrate 24g	**8%**
Dietary Fiber 11g	**44%**
Sugars 4g	
Protein 8g	

Vitamin A 30% • Vitamin C 150%
Calcium 4% • Iron 15%

*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

10. Pasta

Ingredients	Gram
Semolina	920
Chickpea flour	60
Lentil flour	15
Milled flaxseed	25

Pasta Processing

Dry ingredients are mixed and blended.

Dry ingredients are extruded with pilot scale pasta extruder and dried with a pilot scale drier at high temperature drying profile.

Pasta cooking

Dry pasta is cooked in boiling water for 12 min.

Nutrition Facts

Serving Size (56g)
Servings Per Container

Amount Per Serving

Calories 200 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 40g	**13%**
Dietary Fiber 4g	**16%**
Sugars 1g	
Protein 8g	

Vitamin A 0% • Vitamin C 0%

Calcium 2% • Iron 15%

*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

11. Mashed Potatoes

Ingredients	Gram
Potato flakes	100
Milk (2% Fat)	60
Boiling water	180
Butter	30
Salt	5
Precooked Pea Flour	50

Procedures:

Combine boiling water, milk, butter and salt.

Add potato flakes and pea flour. Stir to moisten.

Let stand for two minutes, then stir gently again.

Nutrition Facts

Serving Size (80g)
Servings Per Container

Amount Per Serving

Calories 140 Calories from Fat 40

	% Daily Value*
Total Fat 4.5g	**7%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 15mg	**5%**
Sodium 750mg	**31%**
Total Carbohydrate 20g	**7%**
Dietary Fiber 4g	**16%**
Sugars 3g	
Protein 4g	

Vitamin A 4% • Vitamin C 25%

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

12. Rice Pilaf

Ingredients	Gram
White rice	240
Boiling water	480
Butter	30
Salt	5
Precooked Pea flour	50

Procedures:

Hold rice in boiling water for 15 minutes

Combine butter salt and pea flour in the pot and fry

Add boiled rice on the combination

Add additional boiling water in the pot

Nutrition Facts

Serving Size (80g)
Servings Per Container

Amount Per Serving

Calories 180 Calories from Fat 30

	% Daily Value*
Total Fat 3.5g	**5%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 10mg	**3%**
Sodium 280mg	**12%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 2g	**8%**
Sugars 1g	
Protein 4g	

Vitamin A 2% • Vitamin C 0%

Calcium 2% • Iron 4%

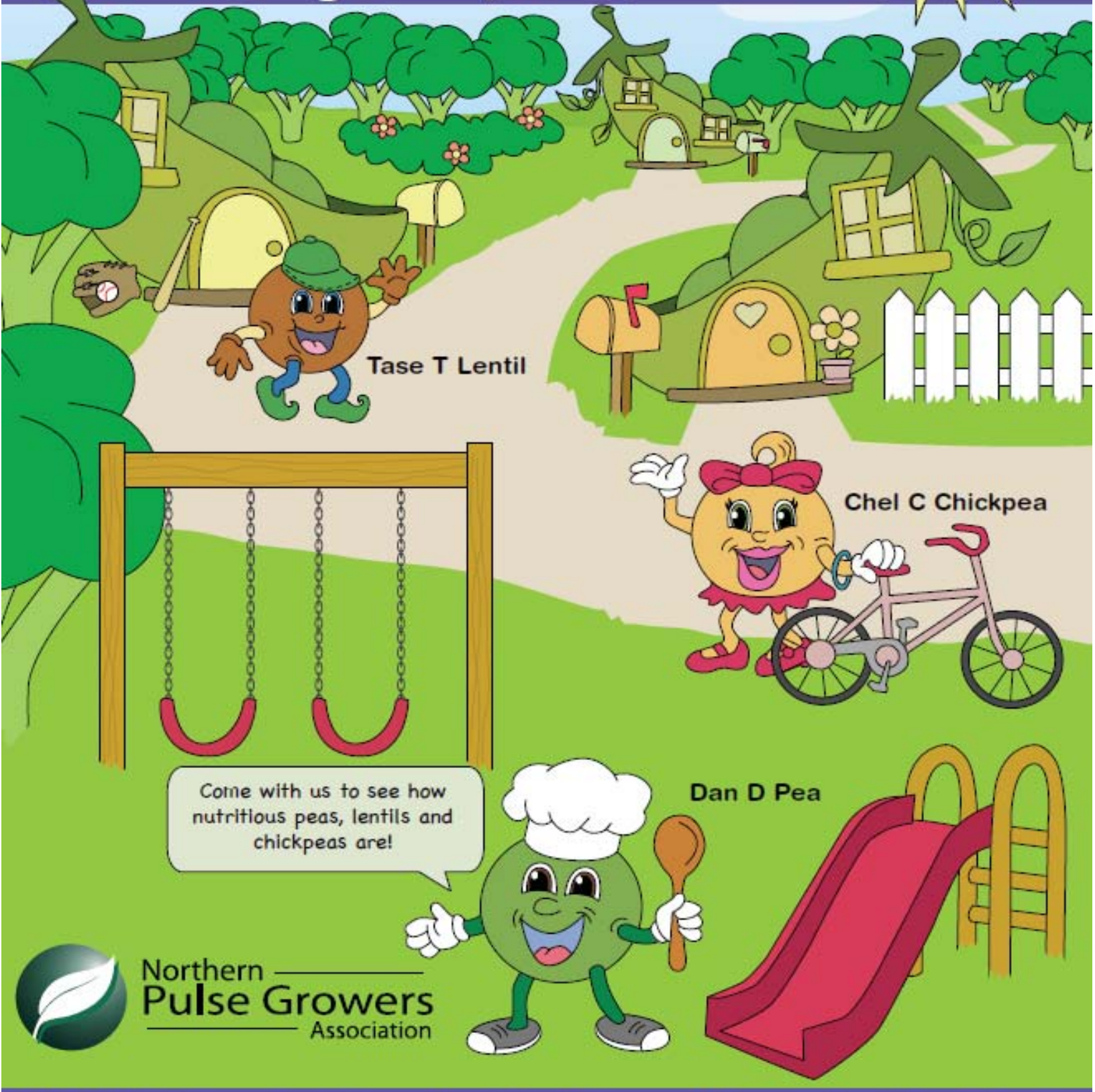
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	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

Super Foods Make Super Kids

Being Healthy is Fun!

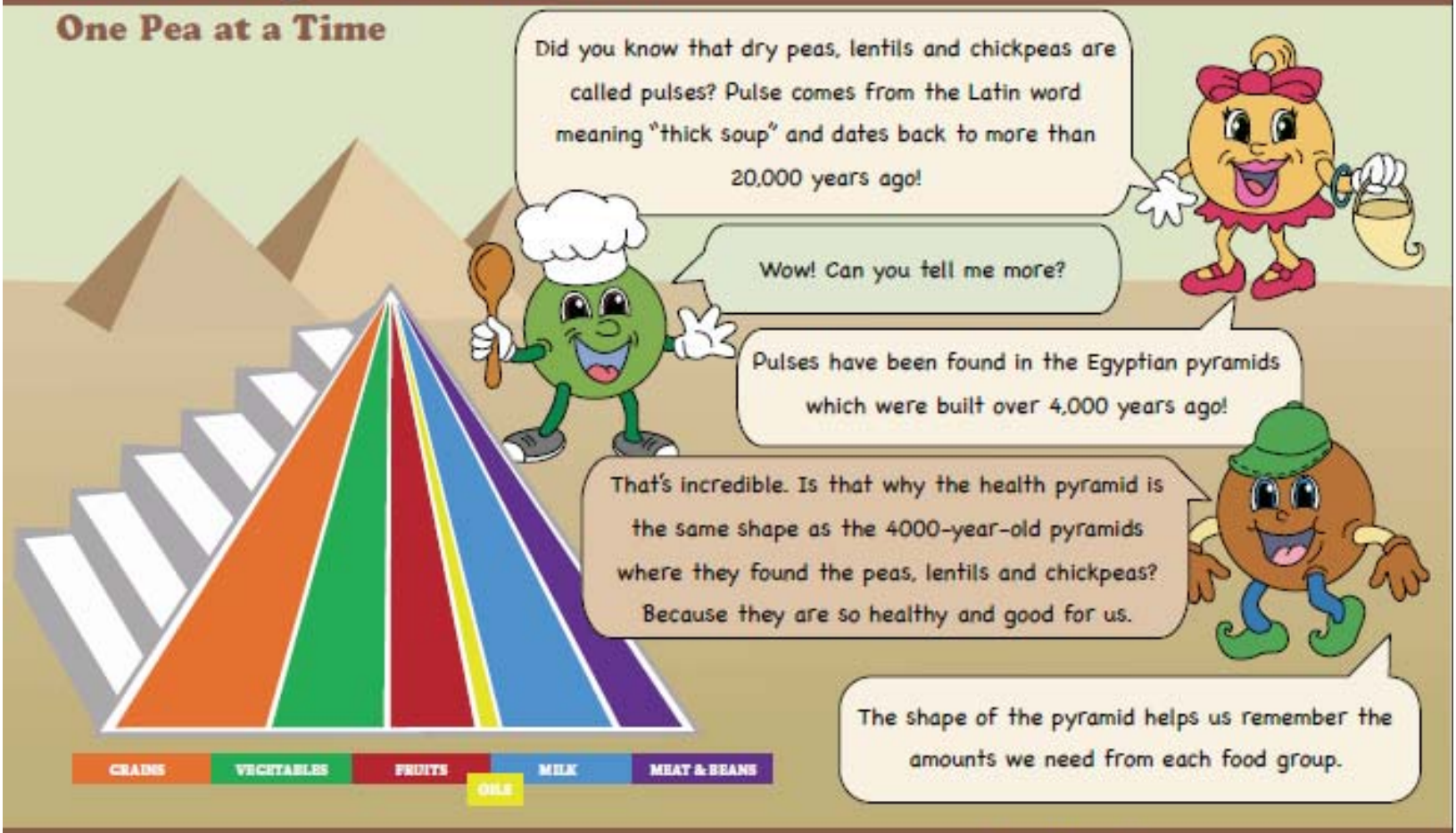


Northern Pulse Growers Association

Meet Chel C Chickpea, Dan D Pea and Tase T Lentil. They would like you to join their adventure!

History of Pulses

One Pea at a Time



SCRAMBLED PULSE WORDS

Unscramble the words below to form pulse words found in this book.

1. MERSARF
2. TISNUOUTIR
3. RADSPMIY
4. EAST T LNELIT
5. LHEC C PCKIHECA
6. TEHALYH
7. OOGD ORF OUY
8. AND D EAP
9. PERSU DOFOS
10. HELATYH DISK

Split Pea Summer Salad

1/2 c. dry green split peas
1 1/2 c. water
16 oz. ham, cubed
2/3 c. Italian dressing (light)
8 oz. bowtie pasta
1 1/2 c. bell pepper, chopped
Salt and pepper to taste

Optional (sliced black olives)

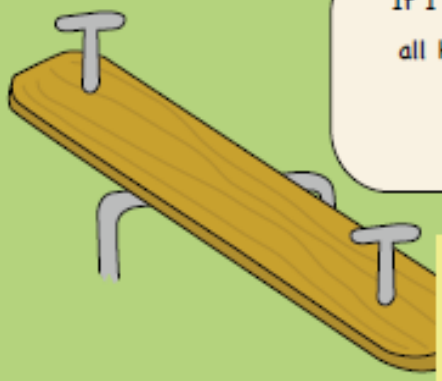
In a medium saucepan, bring peas and water to a boil, reduce heat, cover and simmer until peas are just tender (about 20 minutes). Drain and transfer to a large bowl. Add dressing and set aside. Meanwhile, cook pasta until firm. Toss pasta, peas, pepper and ham. Add salt and pepper. Serve warm or chill and serve cold.

Makes 12 servings. Per serving: 150 calories, 4.5 g fat, 0.9 g saturated fat, 9 g protein, 19 g carbohydrate, 2 g fiber, 500 mg sodium, 1.2 mg iron and 54.7 mcg folate.

Farmers grow peas and lentils, also called legumes, seeds that grow within pods. Legumes are plants that have a special bacteria living on their roots that help make nitrogen. Farmers like growing these special plants because nitrogen is a nutrient all plants need to grow, and legumes are the only plants that make their own nitrogen. People came to like peas, lentils and chickpeas because they are easy to store. Peas, lentils and chickpeas grow in pods and when it comes time to harvest, the vegetable inside the pod is dry and ready for storage, and will last for a very long time. That is why they are called "dry" edible peas, lentils and chickpeas.

That's awesome: peas tell us more.

If I tell you more, we're not going to have time to play on this great playground — and we all know exercise is good for us — but okay, I will tell you more! In 1492, Columbus sailed the ocean blue in search for India. He and his crew were at sea for many months. What kinds of foods do you think Columbus and his crew ate?



What did they eat? Fish?

Mexican Tostadas

1/3 c. lentils
1 1/3 c. water
2 Tbsp. vegetable oil
1 lb. chicken breasts boneless, skinless
2/3 c. finely chopped green onion
2 cloves garlic minced
1 (16-oz.) jar medium salsa (or your choice)
1 c. black beans, drained and rinsed
1 1/2 c. bell pepper, chopped
1 tsp. chili powder
1 tsp. ground cumin
1/2 tsp. salt
8 tostadas
Optional toppings: Shredded cheese, sour cream, guacamole and black olives

In a medium saucepan, bring lentils and water to boil, reduce heat, cover and simmer until lentils are tender. In a frying pan, cook chicken until it reaches an internal temperature of 165 degrees F. Heat oil in a separate pan and sauté onion and garlic in oil, stirring constantly. Reduce heat and add salsa, lentils, black beans and seasonings. Shred or cube chicken and add to the salsa mixture. Continue cooking until heated through. Portion onto tostadas and top with peppers and your other favorite toppings.

Makes eight servings. Per serving (one tostada, without optional toppings): 220 calories, 8 g fat, 1.4 g saturated fat, 15 g protein, 21 g carbohydrate, 3 g fiber, 820 mg sodium, 1.8 mg iron and 19.6 mcg folate.

Yes, but mostly peas, lentils and chickpeas, because they are easy to store, and most importantly, they are nutritious. Pulses are being recognized for their role in promoting good health because they are packed full of protein, fiber and many nutrients. Researchers say that eating veggies every day, especially peas, lentils and chickpeas, may reduce the risk of heart disease, diabetes and certain types of cancer.

Good for you! Even though peas, lentils and chickpeas are vegetables, they have so much protein that they also rank in the meat group! Your skin, bones, and muscles need protein to grow and stay healthy.

The Wicked Witch of the West in the Wizard of Oz must have eaten a lot of peas because she was green.

She may have been feeding peas to her pet monkeys. Did you know that peas are used in pet food, too! They are as healthy for pets as they are for humans. If we exercise and eat healthy as kids, we will grow up to be healthy adults.

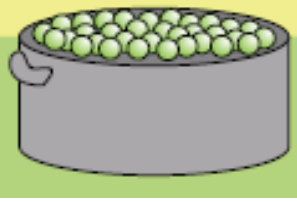
Lentil Mini Pizzas

1/3 c. dry lentils, rinsed
1 1/3 c. water
4 (6-inch) whole-wheat pitas
1 medium zucchini, thinly sliced
1/4 c. red onion, thinly sliced into rings
1/2 c. red bell pepper, chopped
1/4 tsp. black pepper
1/8 tsp. salt
1/2 c. garlic-and-herbs spreadable cheese
6 Tbsp. shredded Asiago cheese (or cheese of choice)

In a 1-quart saucepan, combine lentils with water and bring to a boil; reduce heat, cover and simmer gently until lentils are just tender, about 25 minutes. Drain lentils and set aside. Preheat broiler and place pitas on a nonstick baking sheet; broil for 3 minutes. Heat a nonstick skillet over medium heat; coat with cooking spray. Add zucchini, onion, red bell pepper and salt. Sauté mixture for 3 minutes or until vegetables are crisp-tender. Stir in lentils. Remove pitas from the oven, then spread 2 tablespoons of spreadable cheese on each pita. Top evenly with vegetables and cheese. Broil 3 minutes or until edges are brown and cheese is melted.

Makes four servings. Per serving: 340 calories, 13 g fat, 7.2 g saturated fat, 13 g protein, 45 g carbohydrate, 7 g fiber, 710 mg sodium, 2.8 mg iron and 80 mcg folate.

Pease porridge hot,
Pease porridge cold,
Pease porridge in the pot,
nine days old,
Some like it hot,
Some like it cold,
Some like it in the pot,
nine days old.



Baking with Dan D Pea

Some things you might need to make a cake...

chocolate chips

chickpeas

eggs

sugar

baking powder

Chickpea Chocolate Cake

1 1/2 c. semi-sweet chocolate chips*
1 (15-oz.) can chickpeas, rinsed and drained
4 eggs
3/4 c. white sugar
1/2 tsp. baking powder*

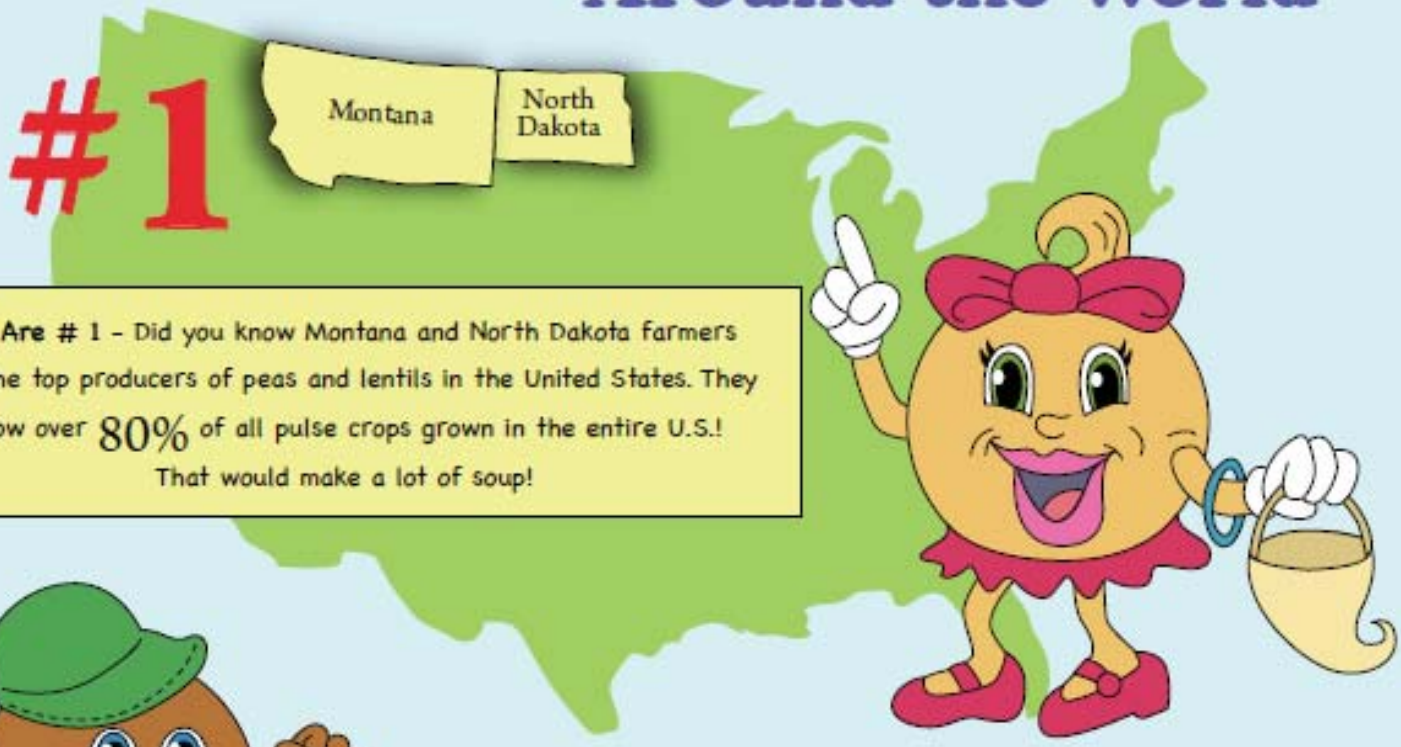
Optional toppings: powdered sugar, frosting or fresh berries

***For a gluten-free cake, check the packaging of these items for gluten-free labeling.**

Preheat oven to 350 degrees F. Grease 9-inch round cake pan. Melt chocolate chips in a microwave-safe bowl, stirring occasionally until chocolate is smooth. Combine chickpeas and eggs in food processor or blender and process until smooth. Add sugar and baking powder; blend. Pour in melted chocolate, then blend until smooth. Transfer batter to prepared cake pan. Bake for 40 minutes or until toothpick inserted in center of cake comes out clean. Cool on wire rack.

Makes nine servings. Per serving (without frosting): 320 calories, 13 g fat, 7.4 g saturated fat, 7 g protein, 47 g carbohydrate, 3 g fiber, 190 mg sodium, 0.8 mg iron and 10.4 mcg folate.

Around the World



We Are # 1 – Did you know Montana and North Dakota farmers are the top producers of peas and lentils in the United States. They grow over 80% of all pulse crops grown in the entire U.S.! That would make a lot of soup!

World Travelers — They travel the world, pea by pea – lentil by lentil. Did you know: India and China are major importers of Montana and North Dakota peas, whereas India and Spain are major importers of Montana and North Dakota lentils.

WORD FIND "Pea-zle"

P	B	D	Q	P	O	Y	R	W	H	Z	C	D	W	L	Y	U	L	K	W
B	U	N	R	W	R	G	C	P	R	O	D	U	C	E	R	S	W	Z	O
E	T	L	M	Y	X	S	D	T	D	G	A	N	H	N	W	S	Z	F	R
U	K	U	S	J	E	F	E	D	S	S	Y	L	I	T	J	B	E	B	K
R	V	Q	B	E	J	D	Q	H	E	G	X	H	C	I	W	H	L	A	I
Q	E	R	R	F	S	G	I	G	G	B	N	J	K	L	A	F	I	F	N
T	W	Q	S	P	T	D	G	B	L	M	S	D	P	S	S	C	V	V	G
S	F	A	R	M	E	R	S	V	L	D	B	F	E	E	D	Y	E	J	F
F	I	P	Q	R	T	Y	P	L	K	E	B	V	A	W	N	T	S	V	O
B	B	H	N	M	O	N	T	A	N	A	P	L	S	P	M	G	T	G	R
K	E	Z	X	G	K	M	D	W	T	Q	D	E	T	Y	L	B	O	W	T
H	R	H	G	O	O	D	F	O	R	Y	O	U	A	X	Y	M	C	G	H
R	R	W	E	R	S	T	K	U	O	F	S	N	M	S	N	K	K	H	E
T	R	T	W	S	N	A	C	K	S	Y	L	U	N	R	I	H	U	K	G
J	F	C	H	U	D	O	Q	Z	I	M	C	Y	P	B	T	O	E	A	R
L	Q	B	S	H	K	D	G	H	J	K	L	C	V	B	R	P	F	U	O
S	I	Q	T	W	E	R	Y	N	P	G	A	T	U	P	O	D	Y	O	W
S	P	R	O	T	E	I	N	V	E	Z	C	N	M	L	G	Z	G	K	E
N	O	A	D	F	H	G	K	N	A	L	E	G	U	M	E	S	G	M	R
N	T	Z	C	V	B	P	O	D	S	K	Q	R	O	P	N	Q	V	B	S

WORDBANK

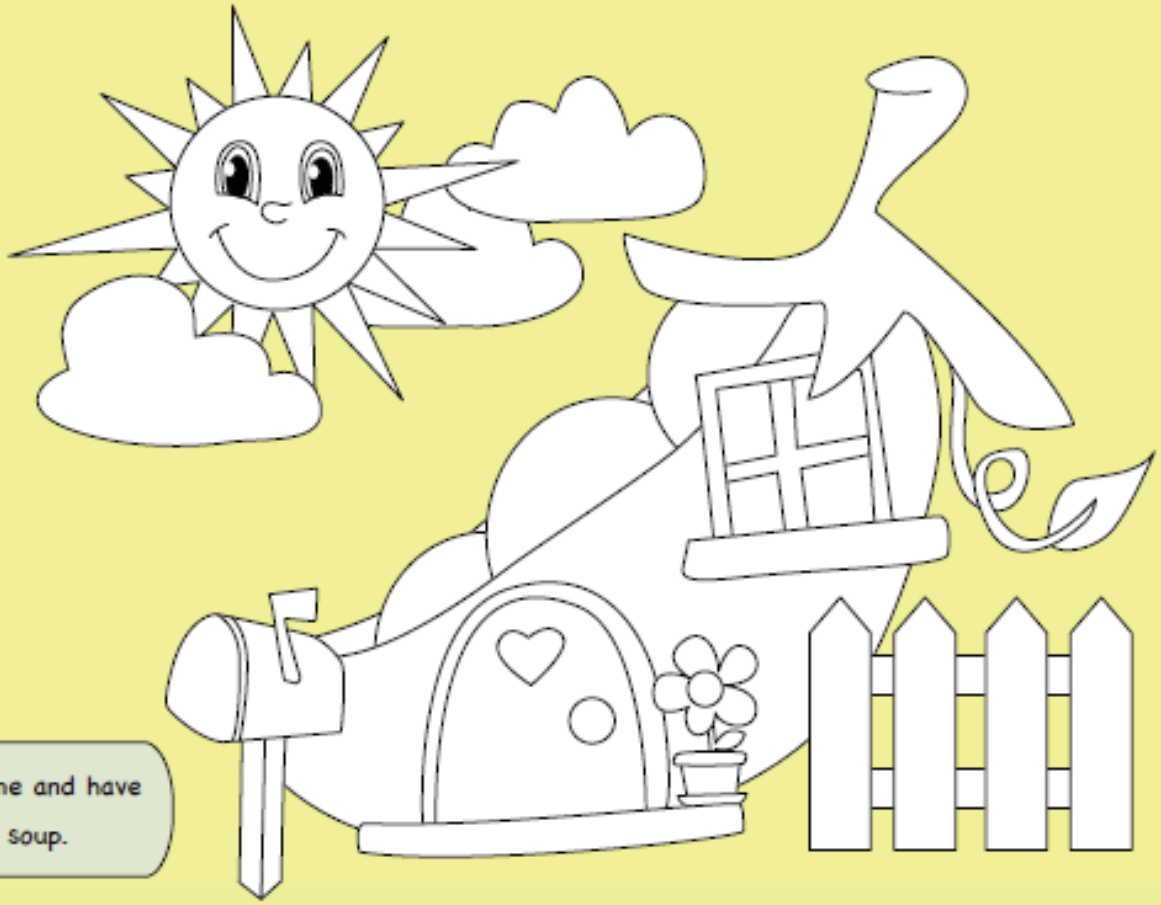
- CHICKPEAS
- DRY EDIBLE PEAS
- FARMERS
- FIBER
- GOOD FOR YOU
- LEGUMES
- LENTILS
- LIVESTOCK
- MONTANA
- NITROGEN
- NORTH DAKOTA
- NPGA
- PEAS
- PODS
- PRODUCERS
- PROTEIN
- PULSES
- SNACKS
- WORKING FOR THE GROWERS

Find the words from the word bank in the puzzle and then use them to fill in the blanks below.

1. Peas, lentils and chickpeas are called _____.
2. _____ _____ and _____ farmers are the top _____ of peas and lentils in the United States.
3. All plants need _____ to grow.
4. _____ come in green and yellow varieties.
5. _____ represents producers of peas, lentils and chickpeas.
6. Feeding pea rations to _____ improves the meat's tenderness.
7. The NPGA's motto is "_____ _____ _____ _____."
8. The healthy snack dip, hummus, is made from _____.
9. Pulses are very nutritious, they have lots of _____ and _____.
10. _____, _____ and chickpeas grow inside _____ and are part of the _____ family.
11. Pulses make healthy _____ and are _____ _____ _____.
12. If _____ were to quit farming, where would we get our food?

SCRAMBLED Answers

1. Farmers
2. Nutritious
3. Pyramids
4. Tase T Lentil
5. Chel C Chickpea
6. Healthy
7. Good for You
8. Dan D Pea
9. Super Foods
10. Healthy Kids



I'm hungry, I'm going to go home and have a warm bowl of split pea soup.

That's a good idea, I'm going to have some hummus.

Wait for me guys, can I eat at your house?

Remember to build healthy bodies one pea at a time. Good-bye everyone — we were peas-ed to meet you!

Northern Pulse Growers Association

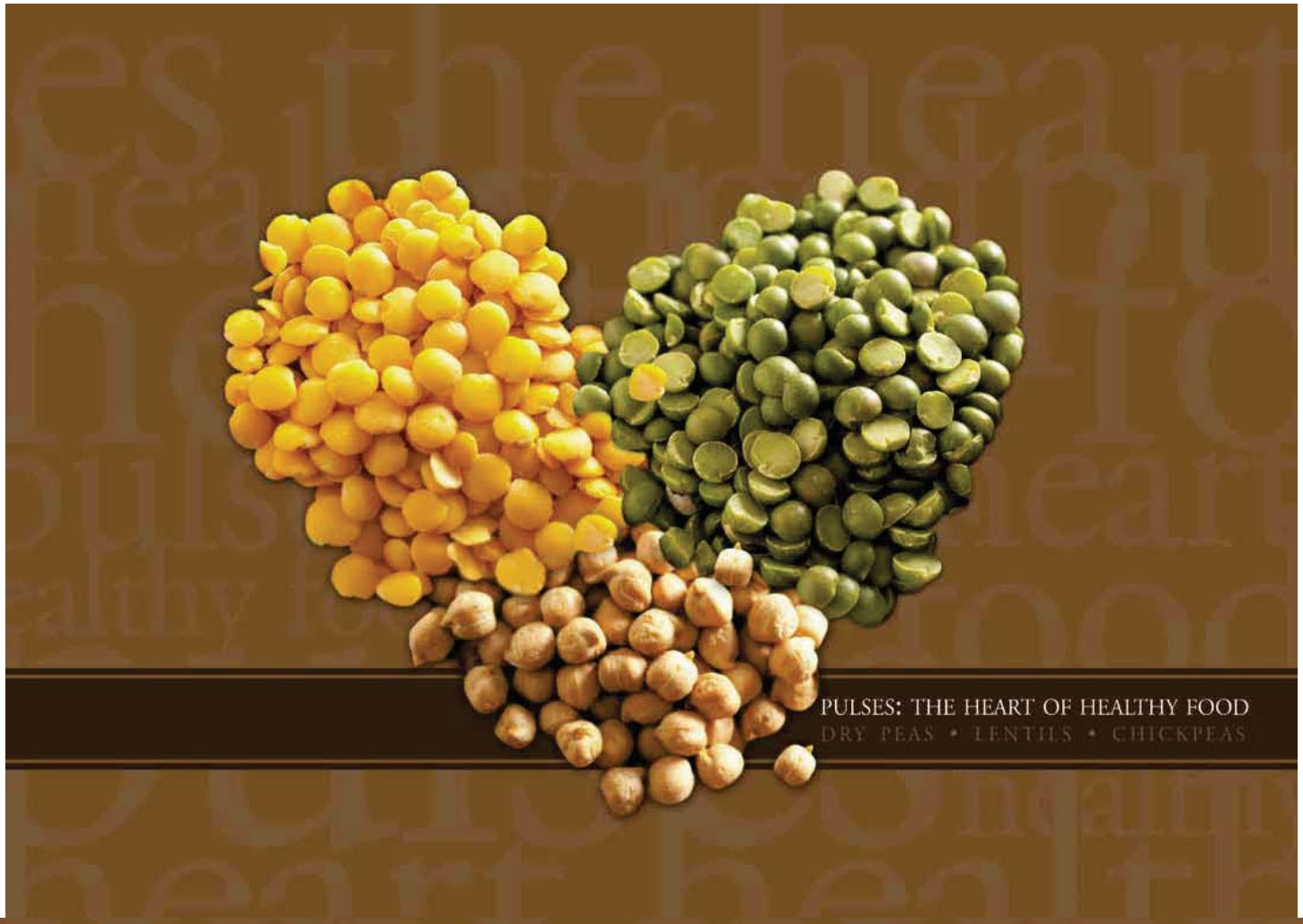
1710 Burnt Boat Drive • Bismarck, ND 58503

(701) 222-0128 • www.northernpulse.com

The NPGA would like to thank the USADPLC for the use of Dan D Pea and Chel C Chickpea characters and the Pullman Chamber of Commerce for the use of Tase T Lentil character.

Photograph Samples

John Borge Studios
Fargo, ND



pulses

HAVE BEEN PART OF THE WORLD'S CUISINE FOR CENTURIES, dating back to the exotic spice trading days. But the ancients who first cultivated these soil-enriching crops as early as 6,000 B.C. wouldn't have guessed they were growing the world's first superfood. Pulses are the nutritionally-packed seeds of legumes and include dry peas, lentils and chickpeas. Today they continue to form the foundation of healthy diets in the Mediterranean, India, Africa, Australia, the Middle East and South America.

Today there's a gastronomical movement that is putting pulses on the American plate to meet growing consumer desires for healthier food that is both adventurous and familiar. Naturally high in protein and fiber, pulses are also packed with complex carbohydrates, antioxidants, vitamins, and minerals like calcium, iron, zinc, folate, potassium and magnesium. Research has confirmed that regular consumption of pulses reduces the risk of chronic diseases such as heart disease, diabetes and certain cancers and may even help combat obesity. But Americans are quite good at snubbing healthy choices if it means sacrificing the fun and flavor of food. Pulses provide a way to have it all.

Bringing the Mediterranean Diet home. The flavor profile of pulses is distinct, yet neutral enough to be exceedingly flexible—a true chameleon of foods. They perfectly adopt the flavor intention of the creative cook, be that sweet, savory or spicy. That also makes them a valuable R&D tool in the effort to put a healthy face on old favorites—from french fries to cereal, pasta to pizza crust—and still mirror traditional expectations of taste and texture.

What's more, pulses offer a way to address the growing demand for foods that fit special diets. Vegetarians, people with diabetes and celiac disease and the millions of Americans allergic to the top eight (milk, wheat, soy, egg, treenut, peanut, fish and shellfish) want more nutritious choices. Pulses deliver. Gluten-free, with high quality vegetarian protein, chickpeas, lentils and dry peas are low allergen and low-glycemic ingredients. Product innovators have a plethora

"IF YOU CAN LOOK INTO THE SEEDS OF TIME,
AND SAY WHICH GRAINS WILL GROW AND WHICH WILL NOT..."
— WILLIAM SHAKESPEARE

of pulse products to choose from: Use these powerful precooked seeds ground into flour or whole or enlist a component in the form of a starch, fiber or protein concentrate or isolate.

FIVE-STAR CULINARY TO THE CORNER DINER

There's no way around the obvious: Healthier diets dictate a change in ingredients. But whether you're trying to satisfy an adventurous palate or match familiar expectations of taste and texture, pulses can help meet the challenge of better nutrition.

WHAT STARTS AT THE CIA WHEN A WORLD-CLASS CHEF CREATES CHICKPEA FRITTERS WITH ROMESCO SAUCE EVENTUALLY RESULTS IN A HEALTHIER, PULSE-FORTIFIED PIZZA CRUST AT THE LOCAL QUICK-SERVE RESTAURANT (QSR).

U.S. culinary trends take root at white tablecloth restaurants then trickle down through the chains and other volume food service establishments. Chefs from these operations are influenced from events like the World of Healthy Flavors leadership retreat hosted by the Culinary Institute of America (CIA). With Chinese, Mexican and Italian fare now mainstream in America, classically-trained chefs at their Greystone, CA, headquarters stand ready to take Asian, Latin and Mediterranean cuisine to the next level. Of late, they've been highlighting the "healthy magic" in dry peas, lentils and chickpeas and the exciting potential of pulses for product innovation.

Great culinary history. Americans are more adventurous eaters today, growing in their understanding and appreciation for world-wide gastronomy and flavor profiles. With Old World flavors and textures again fashionable, chefs are rediscovering chickpeas, lentils and peas in classical Mediterranean dishes and whenever the influence is European, Middle Eastern, Latin, African or South-American.

"Feel good" story. Not only does the intrigue of exotic flavors and textures have fresh appeal, but so does the pulse story. Americans don't want to feel guilty about enjoying a great dining experience. Pulses are "feel good" ingredients, sourced from sustainable, soil-enriching legumes that pack a nutritional punch stronger than soybeans or whole grains. A fantastic source of high quality plant protein, pulses also help chefs meet the growing demand for gluten-free, low-allergen or vegetarian meals without resorting to highly processed protein or fiber additives.

Beyond Soup. Healthy Mediterranean foods needn't taste foreign, though. Pulses have the flexibility to help translate Mediterranean cuisine into American menu items and retail products.

TOP 10 REASONS TO USE PEAS, LENTILS AND CHICKPEAS IN MENU R&D AND PRODUCT INNOVATION

1. EXCELLENT SOURCES OF FIBER.
2. GOOD SOURCES OF PROTEIN.
3. PEAS AND LENTILS ARE FAT-FREE, CHICKPEAS ARE LOW FAT.
4. PEAS AND LENTILS ARE SODIUM-FREE, CHICKPEAS ARE VERY LOW SODIUM.
5. GOOD SOURCES OF IRON.
6. EXCELLENT SOURCES OF FOLATE.
7. LENTILS ARE A GOOD SOURCE OF POTASSIUM.
8. LOW GLYCEMIC INDEX/LOAD INGREDIENTS.
9. GLUTEN-FREE.
10. RICH CULINARY HISTORY; FOUND IN SO MANY FLAVORFUL, CRAVEABLE FOODS.

CULINARY TIPS

- Lightly dust a chicken breast with chickpea flour to give it a beautiful pan-seared crust with just the right hint of nuttiness and gorgeous color.
- Mix a pulse flour (lentil, pea or chickpea) with butter to make a flavorful roux to thicken a sauce or soup.
- Sauté chickpeas with heirloom tomatoes and pancetta and serve with a basil chiffonade.
- Stuff a squash or game hen with red lentils, sausage, garlic and onion.
- Serve up a main course salad by topping a colorful array of cool lentils with shallots, olives and lemon zest. Move over chicken breast—they're also a perfect protein option to the menu's mixed green and goat cheese salad.
- Add lentils to meatloaf. Or, crush them to make a healthy breading.
- Offer hummus or seasoned and sauced lentils as a baked potato topping in place of sour cream.
- Puree cooked yellow split peas, seasoned with oregano and red wine vinegar (the Greeks call this fava) and spread it on bread or thin into soup.
- Send the nutrition and flavor profile of your soups and stews through the roof by making pulses do double duty. Use chickpeas, lentils or split peas as a whole ingredient and puree some as part of the thickening agent.
- Keep that familiar crunch but add more healthy color to salads by replacing bread croutons with the delicious crispness of roasted peas and lentils.
- Try a hard-to-resist yet gluten-free treat of fried chickpea chips. Press cooked chickpeas flat and dust in chickpea flour, then fry deliciously crisp to add a great texture element to a special dish or salad.
- Use cooked green lentils to provide a satisfying protein punch to a thyme, cumin and garlic-seasoned sauté of spinach, onion and a rainbow of bell peppers. (This colorful veggie dish delivers 8g of protein, 11g of fiber and 150% DV of Vitamin C in a 220-calorie serving. Find this and other fabulous pulse recipes at *www.northernpulse.com*.)

MOVE OVER SWEET POTATO FRIES; COOKED LENTILS AND YELLOW PEAS ARE POISED TO BOOT THE POTATO COMPLETELY OUT OF THE FRENCH FRY. Sensory panelists liked the crunchy exterior and core texture of these "pulse" fries as well as conventional fries. With an excellent source of fiber and a good source of protein label, this product is perfect for the bistro and sports bar as well as QSR and the grocery frozen food aisle (see recipe section for formula).

Be it sweet or savory, they have an affinity for herbs and spice. They also handle temperature well, are as delicious cool as served warm, and offer a full range of textures from the crunch of a roasted chickpea to the rich smoothness of a lentil or pea puree. Chefs and product innovators will find it easy to use pulses with signature flavors and concepts to make approachable versions of traditional Old World dishes. Here are some general suggestions from the culinary experts:

- Experiment with pulses as a major component of the dish, rather than just an addition. Great as a major salad item, they can also carry a side dish or serve as a center-of-plate featured ingredient.
- Flaunt the flavor. Pulses deliver great nuttiness and complexity yet adapt well to herbs, heat and spice, rich sauces as well as light sauces, vinaigrettes, sherries and olive oils.
- Routinely reach for a pulse when creating soups, salads, purees and braises. They add a flavor component as well as texture and are a natural thickener.
- Discover the versatility of pulse flours. Beyond bakery goods and pastas, they deliciously dust a protein, flavor or thicken a sauce, or when flaked, create a crust no breadcrumb can match.
- Create healthier menu choices by using a pulse to add a perfect source of protein to a vegetarian dish or balance the nutrition and appeal of the overall meal.
- Pump up presentation with pulses by enlisting their amazing array of colors, shapes and textures.

OLD WORLD NUTRITION FOR MODERN MEALS

As the medical evidence for following the traditional plant-based diets of Asia, Latin America and the Mediterranean region mounts—namely longer life and lower chronic disease rates—the U.S. continues to modify its own dietary guidelines.

U.S. Dietary Guidelines specifically recommend more frequent consumption of lentils, dry peas and beans. People

MACRONUTRIENT CONTENT
OF 100g SAMPLES OF SELECT PULSES, RICE, AND GRAIN

FOOD	CALORIES(kcal)	TOTAL FAT(g)	CARBOHYDRATE(g)	FIBER(g)	PROTEIN(g)
Dry Peas	341	1	60	26	25
Lentils	353	1	60	31	26
Chickpeas	364	6	61	17	19
White Rice	*365*	*1*	*80*	*1*	*7*
Brown Rice	*370*	*3*	*77*	*4*	*8*
Wheat	*329*	*2*	*68*	*12*	*15*
Oats	*389*	*7*	*66*	*11*	*17*

**Source: USDA National Nutrient Database for Standard Reference*

who check out *www.mypyramid.gov* will see that pulses count in both the Vegetable Group and/or Meat and Beans Group. Nutrition experts recommend 2.5 to 3.5 cups of pulses per week. Half of cup of raw pulses yields about a cup of cooked; a cup of cooked pulses equals a cup of vegetables.

Easy-to-meet serving sizes. A full serving of vegetables is provided by a mere ¼ cup of raw pulses because they cook up to a ½ cup serving. Half that or just a ¼ cup of cooked pulses provide a one-ounce equivalent in the meat or beans group, which has a daily requirement of 5 to 6 ounces.

Healthy plant protein. With 7 to 9 grams of protein per ½ cup serving, pulses are a good source of protein and a healthy alternative to meat, replacing saturated fat and cholesterol with a non- or low-fat blend of essential amino acids. Pulses improve the protein quality of cereal grains. Topping white or brown rice with chickpeas or lentils provides the full compliment of amino acids needed for growth.

More than cellulose. Pulses are fiber-rich with both the soluble kind that can reduce blood cholesterol levels and the insoluble kind that promotes digestive health. Most Americans fail to reach the recommended 25g of fiber per day. With 12.5g, 15.6g and 16.3g of fiber respectively, a single cup of chickpeas, lentils or split peas gets them half-way there.

Micronutrients, too. Pulses, especially lentils, are high in the important B vitamin folate, so crucial to reducing the risk of birth defects for women of childbearing age. A cup of lentils provides almost 90% of the daily folate requirement

ANTIOXIDANTS

FOOD	ORAC SCORE
Broccoli	1,362
Carrots	666
Chickpeas	847
Lentils	7,282
Peas (green)	524
Peas (yellow)	741
Oregano	200,129
Pomegranate Juice	2,341
Turmeric	159,277

of 400 mcg. Naturally low in sodium, pulses supply several key vitamins and minerals such as iron, magnesium, potassium, zinc and calcium.

Mega-antioxidant. Pulses are packed with beneficial antioxidants and lentils are an exceptional source. For example, the ORAC score (a test tube measure of the antioxidant level of a food) of lentils is 7,282, more than three times that of pomegranate juice. Research on this antioxidant effect in humans is ongoing.

JUST FOR KIDS

Isn't it time for a healthier "mac and cheese"? With pressure to improve the nutritional quality of kid's meals mounting from both within and outside the food industry, pulses offer a great opportunity to please palates and purses. Pulse protein, fiber and carbohydrates are both high quality and economical, offering easy solutions to meet school lunch guidelines and stay within cost-per-meal constraints.

Picky-eater pasta. Today's parents have a renewed desire to put better nutrition in front of their kids, but no time to cook or fight with picky eaters. Pulses make the process painless because they let restaurants offer nutritionally-enhanced versions of kid-friendly favorites.

- Like a bread stick or pizza crust that provides an excellent source of protein and triple the fiber of the traditional versions made without roasted pea flour.
- Or, how about a serving of pasta with enough protein to give Mom a break from pushing the meat sauce. Another option: Top that macaroni with a creamy puree of chickpeas, peas and/or lentils that colorfully hide other healthy additions like carrots or tomatoes.
- Ditch the bread crumbs on those chicken strips and replace them with a seasoned and baked crispy pea flake crust instead.
- Creamy mashed potatoes get a high-fiber boost (from 0g to 4g in an 80-g, 140-calorie serving) by replacing some of the potato flakes with roasted yellow pea flour. Even the finicky will be fooled: They retain the color, smoothness and aroma of traditional mashed potatoes.
- There's also the deliciously crisp "french fry" of cooked lentils and yellow peas with 5g of fiber and 6g of protein in a 71-g serving. Sensory panelists liked these "pulse fries" as well as conventional potato fries. (See recipe section for formula.)
- Don't forget the cereal. Commercial brands that enlist the nutrition of pulses yet retain the crunch and texture of conventional cereals are beginning to hit grocery store shelves.

Who Cares?

- The Institute of Medicine calls for the restructuring of school lunch guidelines to include more fruits and vegetables and more vegetarian options.
- Improving nutrition was a central theme of First Lady Michelle Obama's "Let's Move" initiative to combat childhood obesity.
- Harvard endocrinologist Dr. David Ludwig spearheads a nationally-recognized attack on childhood obesity for Children's Hospital in Boston, urging parents to decrease portion sizes of high glycemic load (GL) carbs while substituting healthy proteins and increasing consumption of vegetables and legumes like pulses.

HUMMUS: ENJOY A DIP IN DEMAND

- Smooth it over fish or chicken. Slather it on baked potato.
- Spread it on in place of the mayo and mustard.
- Give hummus headline status in that vegetarian sandwich.
- Pair it with raw veggies as well as pita or crackers.
- Create a sumptuous spread by mixing it with whipped cream cheese.
- Blend it with cayenne or cumin, cilantro, green chilies, even habaneros.
- Top it with roasted red peppers, eggplant, scallions or olives.

- "Nutritionally balanced children's dishes" ranks No. 6 out of 208 on a recent National Restaurant Association survey of chefs.
- "Healthy options on kids menus" ranks No. 1 with Quick Serve Restaurants (QSR).

THE HUBBUB OVER HUMMUS

There's no better proof that Americans want healthy to be tasty and convenient than the hummus phenomenon. From a $5M industry in the mid-1990's, hummus sales now top $350M a year. Recent double digit annual growth shows no signs of slowing. This soaring domestic demand explains why only 40% of the chickpeas grown in the U.S. are now exported compared with 90% ten years ago.

THERE'S NO BETTER PROOF THAT AMERICANS WANT HEALTHY TO BE TASTY AND CONVENIENT THAN THE HUMMUS PHENOMENON.

SNACKS ARE MEALS

Busy lives mean Americans are consuming more of their daily calories in the form of snacks. That means a growing market for "guilt-free," more nutrient-dense snacks like hummus. With their deliciously nutty flavor, chickpeas are perfectly poised for other snack food applications. Perhaps crispy chickpea fritters will be next to spread from the fine dining appetizer menu to the grocery heat-and-eat frozen food category.

Like wasabi-laced peas, chickpeas and even lentils roast into a crunchy, hunger-satisfying snack that can stand alone or boost the protein and fiber in a snack bar or trail mix (see recipe section). Pulse flours can make crackers and flatbreads deliver more than just empty carbs and calories. Both pulse flakes and flours serve as a nutritiously crunchy coat for protein snacks like chicken strips or fish sticks.

Hummus is actually the Arabic name for chickpeas. With roots in ancient Egypt and India as well as the Mediterranean region, it's one of the first ever prepared foods. Fast forward to this country's love affair with the healthy spread. When American restaurants enlisted hummus as a pre-meal munchie it prompted their customers to seek the spread at their local supermarket.

Guilt-free snacking. There's no question that consumer interest in healthier eating has spurred hummus sales and promises to pave the way for other pulses as snack food ingredients. High fiber, high protein hummus is also cholesterol and gluten free, and, compared with other snack dips, low in calories. Consumers conscious of improving their diets know that hummus can help them reach their recommended vegetable intake. But taste, convenience and versatility is what put this healthy snack on the fast track. Available in anything from a squeeze tube to grab-and-go 2-ounce snack packs to large, multi-flavor variety packs, hummus makes healthy munching easy to find.

From impulse to staple. More Americans are entertaining at home. Be it a football game or a holiday party, they expect snacks to be heavy hitters. Hummus delivers meal-like nutrition in finger-food style. Touted as the "new salsa" by many in the industry, hummus is also typically paired with chips, but of the pita rather than tortilla variety. And now the traditional puree of chickpeas, tahini, lemon and garlic is giving ground to more adventurous flavors and partners.

Indeed, hummus is a perfect example of adapting an old world favorite to American tastes. It started with simply spicing up classic roasted garlic hummus, then came even spicier red pepper and savory dill-flavored versions. Today's Americanized hummus carries flavors from chipotle to sun-dried tomatoes; salsa to spinach and artichoke. There's even a kid-targeted peanut-butter hummus as well as a cocoa-flavored dessert hummus.

Despite the New World modifications, healthy hummus still basks in the popular Mediterranean Diet limelight. The largest hummus brand in America has seen skyrocketing sales growth by imploring consumers to "go Mediterranean," serving up samples of hummus with fresh toppings in a city-by-city tour that brings its own Mediterranean village to town.

A snack for large and small. While the warehouse giants stock shelves with popular brands or private label hummus, students, vegetarians, athletes and health-foodies are finding and supporting their local hummus bar. Many say the Quick-Serve Restaurant (QSR) is the next frontier.

Room to grow. Despite the impressive sales statistics, the hummus market is still in its infancy. Less than 20% of American homes have invited hummus to the table compared with over 95% household penetration in some Mediterranean countries.

SPECIAL DIET SOLUTIONS

Clean up that label and give special diet foods some real nutrition. Pulses bring boundless possibilities to the process of providing gluten-free, vegetarian, low-allergen and low GI and GL meals that help fight diabetes and obesity.

Vegetarian and Flexitarian. Vegetarian meals aren't just

LABEL-FRIENDLY FOODS

- Drop the allergens and cut the fat from that trail mix. A colorful and tasty peanut, tree-nut and soy-free trail mix awaits the college campus or snack bar category (see recipe section). Roasted red lentils, roasted yellow and green split peas, roasted sunflowers, dried cranberries, semi-sweet chocolate bits, some olive oil and sea salt deliver a deliciously nutty crunch that forced testers to cover and hide this trail mix from sensory panelists. With 60% less fat and 40 fewer calories than the peanut and soy-based control, the pulse trail mix still carried 6g of protein and 2g of fiber per 38-g serving.

- Spike the nutrition in a gluten-free cracker by adding chickpea and pea flour to provide 4g of protein and 2g of fiber in a 40-g serving. (See recipe section).

- Keep that nutty flavor in your basil-and-parmesan pesto by replacing the tree nuts with roasted red lentils. You'll get the same color and texture in a low-allergen pesto that sensory panelists liked as well as the control. Use it to top a salad of cherry tomato, mozzarella, chickpeas and red onion garnished with a crispy sprinkle of roasted lentils. This nutritionally powerful recipe (see *www.northernpulse.com* for recipe) delivers 6g of fiber, 13g of protein plus 60% DV of Vitamin A, 40% DV of Vitamin C, 15% DV of calcium and 15% DV of iron in a 250-calorie, 238-g serving.

- Replace those breadcrumbs with a pea flake coating. Seasoned with fresh herbs, pea flakes add a delicious gluten-free crust to halibut, cod or salmon pan-seared in olive oil. The great texture and flavor profile of crisp, baked pea-flake crusted chicken breast, tenders or strips are a healthy option for center-of-plate or snacks.

- Hold the soy in that veggie burger! Red lentils, split yellow and green peas and black beans clean up that allergen label and deliver a vegetarian burger that sensory liked as well or better than the most popular commercial brand. The pulse burger is perfect for frozen food applications, delivering 7g of protein and 4g of fiber in a 71-g serving.

- Please the vegetarians and flexitarians with a colorful dish that delivers 8g of protein, 11g of fiber and 150% DV of Vitamin C in a 220-calorie serving. A thyme, cumin and garlic-seasoned sauté of cooked green lentils liven up a rainbow of colored peppers, spinach and onion. (See *www.northernpulse.com* for recipe).

WHOLE PULSES, PULSE FLOURS, PULSE STARCHES, PROTEIN AND FIBER COMPONENTS OFFER GREAT OPPORTUNITIES TO MAKE GLUTEN-FREE FOODS MORE WHOLESOME.

for vegetarians anymore. Spurred by John Hopkins School of Public Health advocating "Meatless Mondays," non-vegetarians regularly seek out vegetarian meals. While many of these "flexitarians" are looking for new flavors and culinary adventure, vegetarian entrees are also associated with environmentally-sustainable food production.

Pulses are excellent protein sources for vegetarian meals, and come with an environmentally "green" story. Because they naturally enrich soil with nitrogen, thus reduce the need for petroleum-based fertilizers, pulses are as healthy to grow as they are to eat.

Gluten-free. People who must avoid gluten suffer from celiac disease, an autoimmune disorder. When a celiac-afflicted person eats gluten, it triggers an immune reaction that can damage the intestinal tract leading to poor absorption of nutrients. Gluten-free foods and meals are increasingly popular today, because even though many who avoid gluten aren't formerly diagnosed as celiacs, they have sensitivity to gluten.

Finding nutritious substitutes for gluten is a challenge for celiacs because gluten, a protein form in wheat and many other cereal grains, is found in a huge array of everyday foods. But growing consumer demand promises to fuel improved gluten-free products and pulses are poised to become a major player in this trend. Whole pulses, pulse flours, pulse starches, protein and fiber components offer great opportunity to make gluten-free foods more wholesome.

Low Allergen. With food allergies afflicting up to 4% of the U.S., some 12.2 million people are seeking sustenance that doesn't trigger an allergic reaction. Replacing common allergens with pulses is convenient because of the versatility of whole pulses, pulse flours and pulse components. From egg-replacing pea protein concentrate in baked products to chickpea and lentil flours that can stand in for wheat and soy, to the nut-free crunch of roasted peas, lentils and chickpeas, the opportunity for label-friendly foods is boundless.

Diabetes and Obesity. Because of their high quality complex carbohydrates, pulses digest slowly, meaning diabetics may find their blood glucose levels remain more stable after a meal that contains pulses. With their low-fat protein and fiber-rich carbs, pulses maintain that full feeling after eating longer—an attribute called satiety—which may make weight maintenance easier. It's these factors that make pulses perfect for the low glycemic diet that is being recognized as important in fighting both diabetes and obesity.

HIGH QUALITY CARBS: THE GI FACTOR

Pulses are rich in complex carbohydrates, but even more importantly, they are high quality carbs. Carbohydrates used to be either simple or complex, with the complex carbohydrates of starch and fiber deemed far healthier than simple sugars. But we now know it's more, dare we say, "complicated" than that because our bodies turn even some complex carbohydrates into blood sugar as fast as we do pure sugar. Case in point: potatoes. More than a marketing term, carb quality is a reflection

of the actual metabolic affects of a particular food on the body—namely blood sugar and insulin.

	GLYCEMIC INDEX (GI)	GLYCEMIC LOAD (GL)
Split Peas	25	5
Lentils	28	6
Chickpeas	33	7
Baked potato	98	13
Rice	69	19
Bagel	69	39
Carrots	92	6

The glycemic scale. Glycemic index (GI) and glycemic load (GL) are two measures that reflect the metabolic effect of foods on blood sugar and insulin. Glycemic index (GI) ranks a preset, equal amount of food from 0 to 100 based on how quick and high it boosts the two. Glycemic load makes that index practical by taking into account blood sugar and insulin changes after eating a typical serving size of that food. Bottom line: Pulses are both low GI and low GL foods.

Slow is better. That's because slowly digested carbohydrates, such as pulses, have lower, slower effects on blood sugar and insulin levels. The rapid digestion of refined white rice and white flour breads and pastas sends blood sugar levels soaring quick and fast but can be tempered by topping either with a pulse. In Australia, where the glycemic index is widely used, pulses are regularly employed to reduce the GI of food products. Indeed, the easy pace of pulse digestion may be one reason why pulses tend to combat hunger longer, making them a healthy weight management food.

The case for low GI foods

- One in four Americans is insulin resistant and at risk of developing type 2 diabetes. Low GI diets improve both glucose levels and lipid levels in people with diabetes (both type 1 and type 2).
- Low GI diets reduce insulin levels and improve insulin sensitivity.
- Two out of three Americans are overweight or obese. Low GI diets have weight control benefits because they help control appetite and delay hunger.
- Harvard School of Public Health studies indicate that the risk of chronic diseases such as type 2 diabetes and coronary heart disease are strongly related to the GI of the overall diet.

- In 1999, both the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) recommended that people in industrialized countries base their diets on low-GI foods in order to prevent the most common diseases of affluence, such as coronary heart disease, diabetes and obesity.

PULSE FLOURS

The idea of grinding dry peas, chickpeas or lentils into a high-protein flour isn't a new one; our ancestors were doing it long before machinery was invented to make the process easier. Today, pre-cooked pulse or legume flours are finding a way into a wide variety of products to fortify fiber and protein and improve texture.

Pasta Reborn. The segment is called "better-for-you" pastas and

MACRONUTRIENT CONTENT
OF 100g SAMPLES OF VARIOUS FLOURS

FOOD	CALORIES(kcal)	TOTAL FAT(g)	CARBOHYDRATE(g)	FIBER(g)	PROTEIN(g)
Dry Pea Flour	365	2	65	26	24
Lentil Flour	353	1	65	33	25
Chickpea Flour	387	7	58	11	22
Peanut Flour	*428*	*22*	*31*	*16*	*34*
Potato Flour	*357*	*0*	*83*	*6*	*7*
Rice Flour	*366*	*1*	*80*	*2*	*6*
Corn Flour	*361*	*4*	*77*	*7*	*7*
AP Wheat Flour	*364*	*1*	*76*	*3*	*10*
Whole Wheat Flour	*339*	*2*	*73*	*12*	*14*

**Source: USDA National Nutrient Database for Standard Reference*

PULSE FLOUR R&D

- Add 7% cooked yellow dry pea flour to your breadstick formula and create one that offers 12g of protein (excellent source) and 3g of fiber (good source) per 106-gram serving. This adaptable recipe requires no adjustment in non-liquid ingredients and suits any bread stick application. Color and texture were as good as, if not better than, the control with sensory panelists praising the crunchy crust and soft crumb of the pea flour bread stick.
- Add 8% precooked yellow pea flour to pizza crust formulas and create a 94-gram serving that has 10g of protein (excellent source) and 3g of fiber (good source) and only 240 calories. Get more dough yield in the process because of the extra water absorbing properties of pea flour. Once again, sensory panelists liked the crust as well as or better than the control that had no pea flour in the formula.
- How about a traditional-looking pie crust undetectably fortified with roasted pea flour that delivers 8g of protein and 2g of fiber per 112-gram serving.
- Pump up the protein quality and fiber in white or brown rice without changing the texture by adding precooked pea flour to your pilaf (using a 5:1 ratio of rice to pea flour; see website for formula). The amino acid profile of pulses is a perfect complement to rice, making vegetarian or traditional entrees more nutritious. This pulse-fortified rice is well-suited for fresh or frozen heat-and-serve dishes.
- Fortify a 56-gram serving of semolina pasta with 4g of fiber and 8g of protein by adding chickpea and lentil flours to your formula. This combination gives the pasta a rich, golden color compared with the lighter yellow of straight semolina or the darker shade of whole wheat pasta.

GIVE LOW FAT CHOCOLATE ICE CREAM A SMOOTH, CREAMY TEXTURE BY USING ALL NATURAL PEA STARCH ISOLATE (90%-plus starch) in place of modified corn starch or low-fat gums. Pea starch is so proficient at binding water that it increases viscosity and promotes the smaller ice crystals associated with higher fat ice creams.

with the success of Barilla PLUS leading the way, most pasta brands are jumping on board. Pulses are a big player in Barilla PLUS bestowing it with twice the fiber and more than 40% more protein than traditional pasta.

Whether its pasta fortified with the flour of cooked, yellow split peas or from chickpeas and lentils like those in Barilla PLUS, pulses provide a natural way to preserve traditional taste and texture while bumping up both protein and fiber in grain-based pastas. Pastas with pulses deliver higher quality nutrients with more essential amino acids and complex carbohydrates than wheat-only pastas. The creamy color of roasted yellow pea flour is undetectable in pasta; lentil and chickpea flour will impart a deep golden shade that is still lighter than whole wheat pasta. Another plus: Pulse flours give pasta the added benefit of retaining an al dente texture even when slightly overcooked.

PULSES A'PLENTY

American farmers began a love affair with growing pulses when lentils and peas were included in the 2002 Farm Bill. They've renewed that commitment by planting more acres every year since. That's because pulses are as healthy to grow as they are to eat—replenishing soil nitrogen naturally. This ability to "fix" nitrogen—pull it from the air and put it back into the soil—makes legumes like pulses earn their "green" reputation. Indeed, farmers discovered that traditional crops such as wheat grow better and need less petro-based fertilizer when planted after a pulse crop. That's one reason why pulses have become a permanent player in today's sustainable crop rotations.

With dry peas and lentils leading the way, pulse acres in the U.S. more than quadrupled between 1990 and 2009 pushing 1.5 million acres; farmers are expected to double that again by 2015. This dramatic acreage expansion saw domestic pulse production exceed 1,100,000 metric tons by 2009—triple that produced in the year 2000.

Backed by bricks and mortar. Since the 1990's tens of millions of dollars have been invested in the infrastructure to grow, deliver and process pulse crops in the U.S. U.S. pulse processing has evolved to encompass several state-of-the-art facilities that offer "made to order" splitting, color sorting and packaging of raw pulses. Investment in value-added pulse processing and flour-making continues to escalate.

PULSES ARE AS HEALTHY TO GROW AS THEY ARE TO EAT—REPLENISHING SOIL NITROGEN NATURALLY.

VARIETY OF VARIETIES

It's getting easier all the time to find the right dry pea, lentil or chickpea for your food service application. Investment in plant breeding and testing is resulting in varieties specifically developed for the U.S. In the case of dry peas and chickpeas, varietal differences may influence the size of the seed and the hardness of the seed coat.

Lentils also come in a plethora of types: Reds, browns, greens—and shades in between. Skinless lentils are also called decorticated lentils after the process that removes the seed coat. They are often referred to as red lentils, but there are red lentils that have their outer seed coat intact. The coatless inner seed is called the cotyledon and can be a different color than the outer seed coat, depending on the variety. Skinless lentils absorb water quickly, thus have shorter cooking times and puree easier than intact lentils.

CRACKERS

Ingredient List	Gram	Gluten Free Flours Base %
Precooked pea flour	73	13
Precooked chickpea flour	73	13
Brown rice flour	125	22
Potato starch	121	21
Tapioca flour	172	30
Extra sharp cheddar cheese	80	14
Monterey Jack cheese	80	14
Xanthan gum	6.4	1.1
Shortening	70	12
Salt	7.8	1.4
White granulated sugar	5.5	1.0
Baking powder	4	0.7
High fructose corn syrup	19.4	3.4
Garlic powder	2.5	0.4

Nutrition Facts

Serving Size (40g)

Amount Per Serving	
Calories 150	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 2.5g	13%
Trans Fat 0.5g	
Cholesterol 10mg	3%
Sodium 220mg	9%
Total Carbohydrate 22g	7%
Dietary Fiber 2g	8%
Sugars 1g	
Protein 4g	

Vitamin A 2% • Vitamin C 0%
Calcium 6% • Iron 4%

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

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

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

Procedures

Mix dry. Cut shortening into dry. Flatten the mixture to 2mm thickness on a baking sheet. Bake for 8-10 minutes at 400°F, cut to shape and bake for another 6-8 minutes.

MASHED POTATOES

Ingredient List	Gram
Potato flakes	100
Milk (2% Fat)	60
Boiling water	180
Butter	30
Salt	5
Precooked pea flour	50

Procedures

Combine boiling water, milk, butter and salt. Add potato flakes and pea flour. Stir to moisten. Let stand for two minutes, then stir gently again.

Nutrition Facts

Serving Size (80g)

Amount Per Serving	
Calories 140	Calories from Fat 40
	% Daily Value*
Total Fat 4.5g	7%
Saturated Fat 3g	15%
Trans Fat 0g	
Cholesterol 15mg	5%
Sodium 750mg	31%
Total Carbohydrate 20g	7%
Dietary Fiber 4g	16%
Sugars 3g	
Protein 4g	

Vitamin A 4% • Vitamin C 25%
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

PULSE BURGER

Ingredient List	Gram
Cooked split yellow peas	370
Cooked red lentil	100
Cooked split green peas	100
Cooked black bean	200
Tapioca flour	30.6
Xanthan gum	0.9
Pea protein concentrate	10
Vital wheat gluten	20
Olive oil	20
Cumin powder	0.5
Garlic powder	1
Sea salt	3
Sugar	20
Steak seasoning	7.8
Italian seasoning	1.9
Cider vinegar	1.7
Chopped yellow onion	130
Corn starch	10

Nutrition Facts

Serving Size (71g)

Amount Per Serving	
Calories 110	Calories from Fat 15
	% Daily Value*
Total Fat 1.5g	2%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 180mg	8%
Total Carbohydrate 18g	6%
Dietary Fiber 4g	16%
Sugars 3g	
Protein 7g	

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

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

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

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

Procedures

Soak pulses for at least 30 minutes. Boil them in water until they are thoroughly cooked. Completely drain the water. Heat and mix all the ingredients. Run the mixture through a meat grinder. Add corn starch. Mix. Add onions and form thin patties. Fry with oil until golden brown on both sides.

PULSE FRIES

Ingredient List	Gram
Cooked red lentils	145
Cooked yellow peas	150
Dried onion	6.2
Salt seasoning	14
Dried parsley	0.18
All-purpose flour	60
Sugar	10
Corn starch	15
Water	8

Procedures

Combine all ingredients in a food processor. Sheet and cut the dough into desired shape. Blast freeze the fries. Fry the fries at 180°C for 1-2 minutes or until golden brown.

Nutrition Facts

Serving Size (71g)

Amount Per Serving	
Calories 110	Calories from Fat 0
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 770mg	32%
Total Carbohydrate 23g	8%
Dietary Fiber 5g	20%
Sugars 4g	
Protein 6g	

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

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

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

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

TRAIL MIX

Ingredient List	Gram
Red lentils	60
Split yellow peas	60
Split green peas	60
Roasted sunflower seeds	60
Sweetened dried cranberries	60
Semisweet chocolate chips	74
Olive oil	5
Sea salt	4

To roast peas: Soak 1 hour. Cook for 30 mins, drain and roast for 15 minutes at 360°F.

To roast lentils: Soak 1 hour. Drain water. Roast at 360°F for 18 minutes.

Procedures

Roast peas and lentils. Combine roasted lentils, peas, sunflower seeds, cranberry, and semisweet chocolate chips. Sprinkle with olive oil and sea salt. Mix well and serve.

Nutrition Facts

Serving Size (38g)

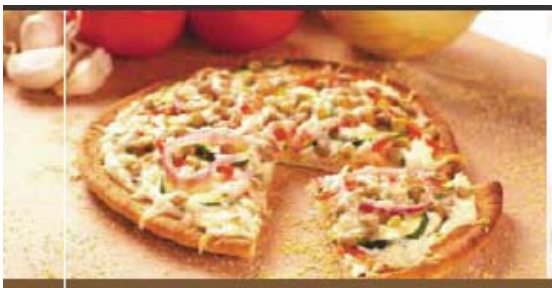
Amount Per Serving	
Calories 160	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 160mg	7%
Total Carbohydrate 22g	7%
Dietary Fiber 2g	8%
Sugars 10g	
Protein 6g	

Vitamin A 0% • 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



PIZZA CRUST

Ingredient List	Gram	Baker's %
High-gluten flour (15% protein)	700	100
Precooked pea flour	115	16
Instant yeast	7.0	1
White granulated sugar	36	5
Vital wheat gluten	21	3
Salt	11	2
Italian seasoning	1.3	0
Water (variable)	597	85
Shortening	14	2

Procedures

Mix the dough. Ferment for 1 hour at 95% R.H., 95°F. Scale to 345g, round, flour, and rest 15 minutes. Sheet the crust, dock top, and put on sauce and toppings. Bake at 390°F for 20 minutes on pizza pan.

Nutrition Facts
Serving Size (94g)

Amount Per Serving	
Calories 210	Calories from Fat 15
	% Daily Value*
Total Fat 1.5g	2%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 270mg	11%
Total Carbohydrate 38g	13%
Dietary Fiber 3g	12%
Sugars 3g	
Protein 10g	

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

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

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

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

LOW-FAT CHOCOLATE ICE CREAM

Ingredient List	Gram	Milk Base %
Whole milk	770	100
Non-fat dry milk	50	6.5
Sugar	130	17
High-fructose corn syrup	45	5.8
Vanilla	10	1.3
Cocoa	34	4.4
Semisweet chocolate chips	80	10.4
Pea starch isolate	8.5	1.1
Water	44	5.7

Procedures

Dissolve pea starch in water. Blend all liquid and dry ingredients. Batch pasteurize (70°C for 30 minutes), homogenize, and cool the mixture. Freeze the ice cream mixture. Package and harden the ice cream in a blast freezer at -30°C.

Nutrition Facts
Serving Size (113g)

Amount Per Serving	
Calories 180	Calories from Fat 45
	% Daily Value*
Total Fat 5g	8%
Saturated Fat 3g	15%
Trans Fat 0g	
Cholesterol 10mg	3%
Sodium 60mg	3%
Total Carbohydrate 30g	10%
Dietary Fiber 1g	4%
Sugars 25g	
Protein 6g	

Vitamin A 4% • Vitamin C 0%
Calcium 15% • 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

BREAD STICKS

Ingredient List	Gram	Baker's %
High-gluten flour	700	100
Pea flour	115	16
Gluten	21	3
Yeast	7	1
Sugar	36	5
Salt	11	2
Shortening	14	2
Italian seasoning	1.3	0
Water	597	85
Monterey Jack cheese	200	29

Procedures

Mix dry ingredients. Add water and mix. Ferment for one hour. Scale to 100g long sticks. Rest for 30-40 minutes in a fermentation cabinet at 85°C, 95% RH. Top with cheese. Bake at 390°F for 20 minutes.

Nutrition Facts
Serving Size (106g)

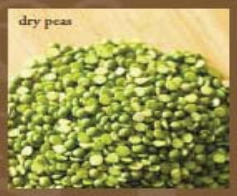
Amount Per Serving	
Calories 250	Calories from Fat 50
	% Daily Value*
Total Fat 6g	9%
Saturated Fat 2.5g	13%
Trans Fat 0g	
Cholesterol 15mg	5%
Sodium 360mg	15%
Total Carbohydrate 38g	13%
Dietary Fiber 3g	12%
Sugars 3g	
Protein 12g	

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



Northern Pulse Growers Association
Bismarck, North Dakota
www.northernpulse.com

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

Northern Pulse Growers Association

FOR IMMEDIATE RELEASE
For more information, contact
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Learn why and how to . . .

Make pulses the heart of perfect foods

Bismarck, ND—December 31, 2010—Pulses such as chickpeas, lentils and split peas are up and coming ingredients to naturally improve a variety of food products and menu items.

Putting their nutritional power to work for you just got easier with a package of new application materials being released this month by the Northern Pulse Growers Association (NPGA), and funded in part by a USDA Specialty Crop Grant. Food product innovators and research chefs will appreciate the Pulse Food Service Guide, complete with more than a dozen formulas for using pulses in everything from pasta, mashed potatoes and French-fries to pizza crust and pesto.

The recipes were developed by the Northern Crops Institute, (NCI) Fargo, ND. Also available are sensory results on all the formulas, completed by NCI and food scientists at North Dakota State University, (NDSU), also in Fargo. "We found that in addition to their excellent nutritional value, pulses show great functional properties in food systems," says NCI's Technical Director Mehmet Tulbek, Ph. D. "End users will see several benefits including yield increase, increased firmness or viscosity and improved texture."

Bringing the Mediterranean Diet home. Chickpeas, lentils and peas have been a part of the world's cuisine for centuries and are the foundation for healthy diets in the Mediterranean, India and South America. Packed with plant-based protein, high-quality complex carbohydrates and fiber, pulses also deliver several key micronutrients such as folate, iron, magnesium, potassium, zinc and calcium. All those nutritional details can be found in the new Pulse Health and

(more)

Nutrition booklet written by NDSU Food and Nutrition Specialist Julie Garden-Robinson, Ph.D., L.R.D. This booklet also includes simple ways to use pulses in everyday consumer recipes from Steak and Chickpea Stir-Fry and Split Pea Salsa to Lentil Mini-Pizzas and Gluten-free Chocolate Cake.

A true food chameleon. The flavor profile of pulses is distinct, yet neutral enough to be flexible. Whether using pulse flours or whole pulses, they perfectly adopt the flavor intention of the creative cook, be that sweet, savory or spicy. Virtually undetectable in many applications, pulses are a valuable R&D tool in the effort to put a healthier face on favorite foods. "Pulses and pulse ingredients will improve the protein quality of cereals, pastas and rice dishes," says NCI's Tulbek. Be it a healthy Mac and Cheese or a protein and fiber-packed breadstick, "they have great potential for improving the nutrition in snacks, kid-friendly foods and pasta," he says."

Guilt-free snacking. Hummus is just the tip of the iceberg. From fritters to extruded snacks, ice cream to crunchy cereals, pulses can deliver full-course nutrition in finger-food style. And, because they are gluten-free, low-allergen and packed with healthy, slowly-digested carbohydrates, pulses are perfect for improving the nutrition of foods for those with celiac disease, diabetes, or common food allergies. Check out www.northernpulse.com for a low-fat but delectable peanut-free trail mix or a crunchy gluten-free cracker formula.

Bakers and pasta developers will find both technical application results and formulas in a new brochure on the use of pea protein isolates and concentrates. This booklet also details the successful results that NDSU food scientists obtained when using pea protein to replace eggs in cakes, cupcakes and pasta. Contact Northern Pulse Growers Association to request your own copy of any of these new materials as well as find them on www.northernpulse.com.

(more)

Northern Pulse Growers Association

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SIDEBAR:

Pulses a plenty

Finding a long-term dependable source of domestically grown chickpeas, lentils and dry peas won't be a problem. Pulses have become a routine part of many farmers' crop rotation plans. Now, both acreage and yields are poised to explode in the United States, particularly in the Northern Great Plains states such as Montana and North Dakota.

Green, "feel-good" food. It turns out that pulses are as healthy to grow as they are to eat. Because they are legume plants, pulses naturally replenish soil nitrogen, pulling it from the air and placing it back in the soil thereby reducing the need for costly petroleum-based fertilizers. "Pulse growers recognize the economic and agronomic benefits that pulse crops provide," says Shannon Berndt, executive director for the Northern Pulse Growers Association (NPGA).

"Besides 'fixing' nitrogen in the soil, they reduce greenhouse gases and help lower carbon emissions which are key functions in sustainable global food production."

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PROJECT TITLE

Does the inclusion of field pea components in beef finishing diets influence beef palatability attributes of multiple muscles in cattle genetically indexing for poor carcass parameters?

PROJECT SUMMARY

The objectives of this project were to: determine effect of including components of field pea and whole field pea in finishing diets on carcass quality traits of cattle scoring in the lower one-third index for Igenity® genetic markers palatability traits including tenderness and marbling and to compare mechanical tenderness test results and human sensory panel response for ribeye, inside round, outside round, and chuck tender muscles from steers fed field pea or no field pea in a corn-based finishing diet. We know that field pea is an excellent energy and protein source for beef cattle in various stages of growth and development (Anderson et al., 2007). There is no data on the feed value and cattle performance for components of field pea (hulls and endosperm). Variation in tenderness is consistently the number one criteria for eating satisfaction of beef in consumer surveys and the Beef Quality Audits done in the past several years. Previous studies finishing yearling heifers (Carlin et al., 2006) found a highly significant improvement in ribeye tenderness with 10% or more dietary field pea fed for 76 days. No additional improvement in tenderness was observed when field pea was included at 20% or 30% of DMI. Magolski et al., (2008) also observed a positive trend for improved ribeye tenderness in steers fed field pea at 20% of DMI during different stages of the grow-finish feedlot phases. Field pea is a valuable commodity for human food, with significant export potential. Feed peas are not competitive priced with human food grade markets but the goals of this study could help to increase the value of peas for feed. Some components of field pea, such as the hulls and the chips from the splitting process are often available as feed in limited quantities. Utilization of these components for this study was to determine what component of the field pea is responsible for the change in tenderness of beef steaks.

PROJECT APPROACH

Dr. Vern Anderson and Breanne Isle completed the feedlot portion of the experiment. Briefly, one hundred twenty six crossbred (Angus x Piedmontese) heifers were weighed, randomly allotted to one of 16 pens at the Carrington Research Extension Center in May 2010, and fed for ~120 days on a corn-based ration. The ration treatments were 1) no field pea (control; CON) 2) dry rolled field pea included at 15% of the diet DM (WRL); 3) pea hulls fed at the equivalent proportion to 15% whole peas in the ration (HULL); and 4) pea chips fed at the equivalent proportion to 15% whole peas in the ration (CHIP). Heifers were fed in 16 identical pens with four pens (replicates) on each treatment. Feed intake was recorded daily for the totally mixed ration and steers were weighed individually every 28 days to monitor performance during the feeding period. Feedlot performance parameters were determined. Samples were taken from the ear of each heifer and Igenity® profile was determined. Heifers were transported to North Dakota Natural Beef in New Rockford for slaughter. Drs. Kasey Carlin and Eric Berg were charged with completion of the meat science portion of the project. Carcass traits were measured and included USDA Quality and Yield Grades determined by Dr. Robert Maddock. Each heifer was evaluated by the Igenity® genetic selection tool for the full marker profile which includes tenderness, docility, yield grade ribeye area, fat thickness, marbling, and quality grade. Since the

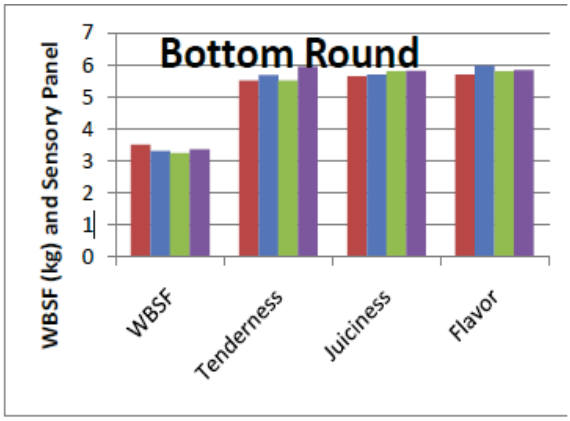
cattle had Peidmontese genetics, they were also evaluated for mutations in the myostatin gene, which may affect meat palatability. The Igenity® results allowed us to identify those steers that are genetically similar relative to producing tough beef. The longissimus thoracis (ribeye roll), semimembranosus (inside round), biceps femoris (outside round), and supraspinatus (chuck tender) muscles were removed, two steaks cut from each muscle, were vacuum packaged, and aged for 14 days then frozen. Collection of steaks was conducted at the ND Natural Beef Plant in Fargo. With the cooperation of plant employees and help from graduate students, undergraduate students, and technicians, steaks were cut from wholesale primal cuts removed from the carcass by plant workers. Warner-Bratzler shear force was determined as the average of six cores from each steak cooked to a medium degree of doneness from each steer according to the American Meat Science Association guidelines. Trained sensory panel analysis was conducted on the steaks for determination of tenderness, juiciness, and flavor components of the various beef steaks from different muscles. Briefly, eight trained panelist were served a 1 cm x 1 cm x 2.54 cm portion of a steak cooked to a medium degree of doneness on a clam shell grill. They scored each sample on a hedonic scale from 1 to 8 (1 = least tender, least juicy, and least flavor and 8 = most tender, most juicy, and most flavor).

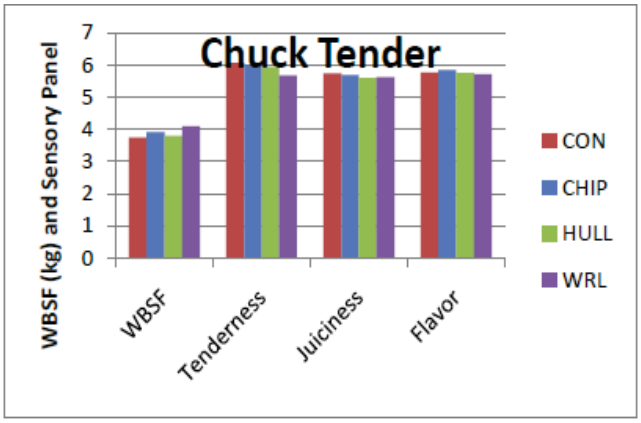
GOALS AND OUTCOMES ACHE IVED

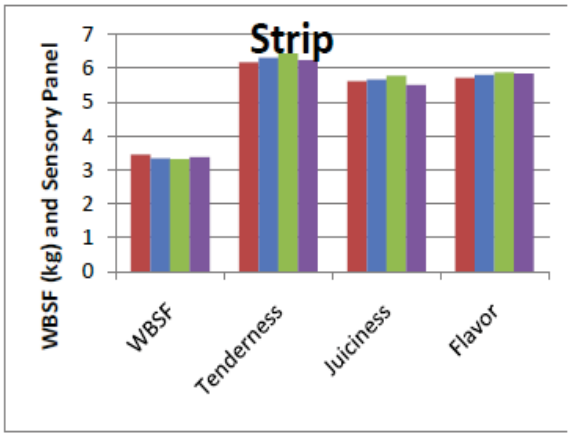
Timeline

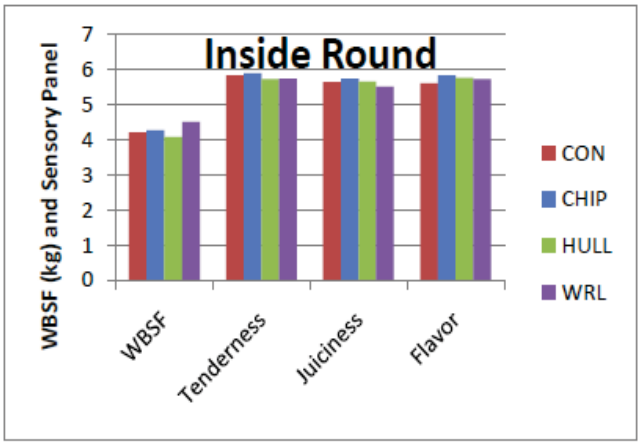
Project Activity	Who	Timeline
Fed 126 steers and measure feed intake, gain, and feed efficiency for the four treatments with four replicates each in sixteen pens	Anderson and Ilse	May 20 10-September 2010 (COMPLETED)
Evaluated carcasses of all steers	Carlin and Berg	September 2010 (COMPLETED)
Collected multiple muscle samples from each carcass	Carlin and Berg	September 2010 (COMPLETED)
Evaluated tenderness of muscles using Warner Bratzler Shear Force (WBS) methodology	Carlin and Berg	December 2010 (COMPLETED)
Conducted taste panel evaluation of multiple muscles	Carlin and Berg	October-November 2010 (COMPLETED)
Summarized and report feeding performance and carcass data	Anderson and Ilse	Dec.2010- Jan 2011
Summarized and report WBS and taste panel results	Carlin and Berg	Jan 2011 (COMPLETED)
Report findings to pea producers, beef producers, beef and meat industry at scientific meetings	Anderson, Ilse, Carlin, and Berg	July 2011

The results of the taste panel and mechanical tenderness tests (shear force) indicate that there was no effect of field pea component on meat tenderness, juiciness or flavor regardless of muscle cut or Igenity® profile score in this experiment. The results are in contrast to previous studies that indicate field pea inclusion in feed lot diets had a positive impact on meat palatability, specifically tenderness. It should be noted that the tenderness evaluations indicated that the steaks used in this experiment were of acceptable quality, thus field peas did not improve on already acceptable meat tenderness. Results of Warner-Bratzler Shear Force (WBSF; kg) and Sensory Taste panel are shown in the figures below, which are separated by steak type. There were no significant differences (P > 0.25) in any of the reported components due to treatment. However, heifers from this study were slaughtered on two different slaughter days one week apart. Interestingly, there was a slaughter date effect on WBSF and tenderness for all steak types with slaughter date two having superior tenderness. There was not a treatment x slaughter date interaction, thus the interactive means are not reported as it does not affect the main goals of the study.









BENEFICIARIES

The beneficiaries of this project are the pulse growers, processors and livestock producers who have access to field pea. This study gives pea growers and processors animal performance data that will be useful in marketing components of field pea as well as off quality field peas. Processors have increased the price of the co-products they produce by over $100 per ton because of this study and the successful feedlot performance of the animals fed pea and pea components. The increase in price for co-products will increase the price processors can pay pulse growers for peas and should increase acres of production and profit potential for growers. Although this project did not have the expected results of increasing beef tenderness through feeding field pea components, it did illustrate the field peas make an excellent feedstuff for finishing diets for feedlot cattle and does not have any adverse effects on performance or meat quality. Additionally, it may provide a place to utilize the components of field peas that are wasted during the splitting process.

LESSONS LEARNED

This project was conducted through the cooperation of the Carrington Research and Extension Center and the NDSU-Main Station and the help of the private business (North Dakota Natural Beef). This project was conducted with the efforts of four scientists, numerous technicians, four graduate students, and three undergraduate students. The students learned about animal feeding and nutrition, feedlot management, packing plant operations, meat cutting, experimental design, and meat palatability techniques and analysis. The results of the project were contrary to previous research and indicate that, although field peas increase meat palatability, there is another aspect finishing cattle that affects palatability when feeding field peas and provides another research avenue for the scientists conducting this research. Research will continue on field peas in beef cattle feedlot diets to determine other factors that interact with meat palatability while utilizing field peas.

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Vern.Anderson@ndsu.edu

PROJECT TITLE

Introduction of rust resistance genes into confectionery sunflower

PROJECT SUMMARY

Sunflower rust *Puccinia helianthi* is a serious disease that has been increasingly prevalent in much of the U.S. sunflower producing region. Confection sunflower is particularly vulnerable to the disease. The disease can dramatically lower yield and reduce quality of the seed. Developing genetic rust resistance in confection hybrids is the goal of this project. The project will incorporate three identified rust resistant genes into two acceptable confection genetic backgrounds and make them available to the private seed industry for incorporation into finished commercial hybrids. The resistant genes will be molecularly 'marked' for ease of identity in the numerous backcrosses that will be required. Resistance to rust is an important agronomic factor in keeping U.S. confection sunflower competitive in key international markets. This project has not been submitted or funded by another Federal or State grant program.

PROJECT APPROACH

Our approach has three parts. First, we made two to three generations of backcrosses each year. We obtained BC_2 generations for three combinations. Rust screening was applied to each generation to select resistant plants for backcross. Approximately seven generations with plant material containing a resistant gene will be required for the final product. Second, we developed molecular markers linked to the rust resistance genes R_4 and R_5 which are the current candidate genes of choice for introgressing into confectionery sunflower. Continued presence of the rust resistant gene will be confirmed by genetic DNA markers. In addition, each generation will show agronomic improvement in terms of plant vigor, plant height, seed size and seed color. These are all quantitative factors. Third, we are working on mapping of new rust resistance genes found in the inbred lines HA-R6, HA-R8, RHA 397, and RHA 464. The line HA-R6 is the only confection type known harboring a rust resistance gene.

GOALS AND OUTCOMES ACHIEVED

The goals for 2010

1. Create BC_2 (backcross) generation in fall greenhouse
2. Begin the process of identifying molecular markers for the resistant gene
3. Test all generations in laboratory/greenhouse for resistance

Outcomes achieved in 2010

1. Identification of sunflower breeding lines for resistance to new rust races

Rust race 336 is the predominant race in North America and race 777 is the most virulent race currently known. A total of 104 entries, including 66 USDA-released inbred lines, 14 interspecific germplasm lines, and 24 foreign germplasms, all developed specifically for rust resistance, were tested for their reaction to races 336 and 777 under controlled conditions in the greenhouse. Only 13 of the 104 entries tested were resistant to both races, whereas another six were resistant only to race 336. Among the 19 resistant lines, only one inbred line, HA-R6, is the confection type. Three selected rust resistance genes in this project, R_2 in MC29, R_4 in HA-R3, and R_5 in HA-R2, were highly resistant to race 336 and slightly susceptible to race 777. A combination of MC29 with HA-R2 or HA-R3 was resistant to 98% of U.S. rust isolates. Two recently released confection inbred lines, CONFSCL B1 and CONFSCL R5, selected as recurrent parents in the present study, are highly susceptible to both races.

2. Production of BC_2 generations

The crosses were made between CONFSCL B1 and both MC29 and HA-R2, as well as between CONFSCL R5 and HA-R3 in the greenhouse in winter 2009. The BC_1 seeds from crossing three F_1s to their recurrent parents were obtained in spring 2010. We screened 30 plants from each of the three BC_1s with rust race 336. The resistant BC_1 plants were selected and backcrossed to the recurrent parents to produce the BC_2 populations. Thus, Goals 1 and 3 for 2010 were met.

3. Development of molecular markers linked to rust resistance genes R_4 in HA-R3

Molecular markers linked to the rust resistance gene R_2 were previously reported and will facilitate the marker-assisted selection in the backcrossing. We currently mapped the rust resistance gene R_4 to the sunflower linkage group 13. Two markers, ZVG61 and ORS581, are tightly linked to the R_4 gene, providing molecular markers targeting this gene in breeding programs. Consequently, Goal 2 for 2010 was achieved.

4. Development of new mapping populations for rust resistance gene mapping

From our survey, four USDA-released lines, HA-R6, HA-R8, RHA 397, and RHA 464 are resistant to both rust races 336 and 777. The rust resistances in these lines are from different origins, indicating diverse genetic sources. Each of these four lines was crossed with susceptible line HA 89. Four F_2 mapping populations were developed from the crosses and advancement from the F_2 to F_3 generations is underway.

5. A Postdoctoral research associate, Li Gong, was recruited in July 2010 and moves the project forward.

BENEFICIARIES

The beneficiaries are broad and varied. It is estimated that 825 farmers nationwide (half of whom are in North Dakota) will benefit directly by rust resistant hybrids. The cost of a fungicide application varies between $14 and $24 per acre, depending on which fungicide is used. With an average cost of $17.30 per application, the

costs would equate to $6 million nationally of which $3 million would be in North Dakota. In early and severe infestations confection sunflower fields would require up to three applications resulting in costs of $18 million nationally and $9 million in North Dakota. Those farmers choosing not to spray a fungicide could lose 80 percent of their potential yield and the remainder of the crop would not be marketable. In an experimental strip in 2008 near Minot ND the yield was reduced from 1400 pounds/acre to 400 pounds/acre when no fungicide was used. That yield loss represents $350 per acre. The unmarketable remaining 400 pounds of production due to low test weight and discolored seed would represent an additional $140 per acre. Host resistance is the most effective way to control the disease and reduce the yield loss. This is a three-year project. When further progress is made the NSA will write a story on this research for *The Sunflower* magazine that goes to all U.S. growers and industry persons. The project researchers will be reporting on their first full year of progress at the annual NSA Research Forum in January of 2012. That report will reach key seed company breeders and grower leaders. That report will be available in late January 2012 on the NSA website http://www.sunflowernsa.com/research/searchable-database-of-forum-papers/. This site is accessible to anyone.

LESSONS LEARNED

This is only Year 1 of a proposed 3-year project, so it is a little early to offer insight into lessons learned. However, one result that was largely unanticipated was the lack of resistance to newer races of rust in the sunflower Plant Introductions that were previously classified as rust resistant in the sunflower GRIN (Germplasm Resources Information Network) database. It demonstrates that "rust resistant" lines must be checked for resistance to the new rust races before enlisting them into breeding programs. This is a high priority project and it will continue under separate funding if this grant is unavailable.

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ADDITIONAL INFORMATION

Publications

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

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

Northarvest Bean Growers Association
Final Report

Project title: Strengthening Value-Added Programs for Dry Edible Beans

Outline of the Issue/Need for Projects
This project includes three Subprojects intended to advance the health promotion and research strategy of the Northarvest Bean Growers Association through **(a)** increase knowledge of dry bean-health benefits among an expanded number and classes of health professionals; **(b)** increase consumer awareness of bean-health benefits by reviewing and preparing evidence supportive of a structure-function claim; and **(c)** advance basic knowledge about the human health potential associated with three classes of compounds present in beans.

Project Summary
At the beginning (October 27th, 2009) of this project, "Strengthening Value-Added Programs for Dry Edible Beans", Dr. Bill Lesch, Chair of the Marketing Department for the University of North Dakota, was designated the overall project leader. By January of 2010, Dr. Lesch no longer served as overall project leader. Northarvest worked with Communiqué to handle the newsletter development and distribution, but Dr. Lesch only continued to oversee the web development. Once the web was live, Communiqué also took on the day to day activities of web management and continued development.
This promotion project include expanded, regular electronic (website and newsletter) and postal newsletter communication to dieticians. A scientific literature review was initiated to determine if one or more statements known as "structure-function" claims could considered for use by the trade in labeling and advertising of dry beans to consumers. Finally, three (3) lines of basic scientific inquiry were undertaken to unravel the possible links between dry beans and health, these involving starches, polyphenols, and trichloroacetic acid (TCA). These bean-attributes are believed helpful in the areas of glucose regulation, antioxidant (anti-cancer), and cholesterol-reduction for humans. This project builds on three previous/current Block-grant programs.

Approach
(a)
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. The first issue of Dry Bean Quarterly (DBQ) was distributed electronically and reviewed by 6,425 registered dieticians on June 11, 2010. DBQ is also posted online at www.beaninstitute.com. Following the electronic release of Vol. 1 No. 1, Communiqué developed the layout and design for the print newsletter and it was mailed out. We found authors for Vol. 1, No 2, and held a conference call with the editorial board for feedback and planning on future issues of DBQ for July and August (3 and 4, respectively). DBQ Vol. 1 No.2 was emailed to 30,000 registered dieticians and mailed to 10,000 dieticians. We contacted the authors for Vol. 1 No. 3 and collected materials from the author and provided print ready proof to editorial board and Northarvest. The October/November final edits on No.3 were made and emailed to 30,000 registered dieticians and an additional 10,000 received a printed copy. In mid December, we contacted potential authors for No. 4 and developed and distributed DBQ to 30,000 registered dieticians by email and an additional 10,000 received printed copy.

(b)
Northarvest originally planned to reach an agreement to use existing proprietary literature review with Pulse Canada. After learning Pulse Canada was at risk to be shut down and finding that the person of expertise was no longer with them, Northarvest decided to designate Communiqué. The review of the existing scientific research was conducted by Dr. Mark Messina, whom specializes in these types of discovery. Since Pulse Canada was not a part of this project, we ended up starting this project from scratch instead of expanding on information. After Dr. Messina was hired, he researched the World Wide Web to review all literature that would lead to a claim. The conclusion from this project is there may be enough evidence to support a claim in one of the four research projects. The four results that may have enough evidence to support a structure-function claim include the following; Resistant Starch in Beans Could Improve Satiety, Americans Don't Consume Enough Legumes, Beans Help with Weight Loss and Lower Chronic Disease Risk, and Bean-Fortified Spaghetti Has a High Protein Content and Low Glycemic Index. Once a claim is supported, it can be used by the trade in labeling and advertising of dry beans to consumers. Further research on these projects is being done to support a claim.

(c)
April 1, 2010 Northarvest entered into an agreement with Atanu Biswass at NCAUR, Peoria Illinois to advance basic knowledge about the human health potential associated with three classes of compounds present in beans, (polyphenols, TCAs, and starch). Northarvest shipped NCAUR large quantity samples of 8 classes of beans, which they tested. The results include a total of five manuscripts (See Goals and Outcomes Achieved), as well as the completion of the following goals: to isolate and identify the range of polyphenolics in beans, conduct literature reviews to compare antioxidant capabilities, establish database of phenolic compounds and their properties, characterize physical and select functional characteristics of bean starches, and determine comparative hydrologic properties of starches. The research to determine bile-binding capacities of isolated compounds and isolate and characterize TCA fractions from beans were not completed due to the postdoc leaving, but will be taken over by a new examiner in 2012 and final results will be included in a review article. Further research is being done and we fully expect to successfully complete what we set out to do.

Goals and Outcomes Achieved
(a)
Three creditable electronic and print newsletters were developed and directed to a select audience of influencers (now 40,000 up from Number 1's electronic audience of 6,400) to tout the health benefits of beans and distributed timely.
Volume 1, Number 1 — Dry Beans and Obesity
Volume 1, Number 2 — Dry Beans and Cancer
Volume 1, Number 3 — Dry Beans and Cardiovascular Disease
Volume 1, Number 4 — Dry Beans and Diabetes

Vol. 1, No. 1 was all electronic. Vol. 1 No. 2 went to the Oncology Nutrition, Weight Management, Diabetes Care & Education, Food & Culinary Professionals, and Sports, Cardiovascular & Wellness Nutrition practice groups.
Vol. 1 No. 3 went to Oncology Nutrition, Weight Management, Diabetes Care & Education, and Sports, Cardiovascular & Wellness Nutrition practice groups.

Vol. 1 No. 4 also went to Oncology Nutrition, Weight Management, Diabetes Care & Education, and Sports, Cardiovascular & Wellness Nutrition practice groups.

For each issue, we tried to mail to the group that the issue targeted before sending to the others. So, for No.2 we emphasized the Oncology Group, No. 3 we emphasized the Cardiovascular Group, and for No. 4 we emphasized the Diabetes Group.

Google Analytics showed web traffic spiked to 328 unique visitors following the first newsletter. It rose further to 393 unique visitors on August 3, 2010, the date the second newsletter was emailed. It rose to 238 unique visitors on November 3, 2010, the date the third newsletter email was sent. In total, 568 clicked through from the first newsletter email to the website, 521 clicked through from the second email to the website, and 492 clicked through from the third newsletter email to the website. The fourth issue of the newsletter was deployed on December 15, 2010, and there we noticed a change in the pattern of usage. Though 509 clicked-through from the email newsletter, the spike in the initial day doesn't look as big; partially because it was sent late in the day, which caused it to be spread over a couple days. More importantly, though, the traffic starts to pick up, and we see dozens of users that are seeking out BeanInstitute.com and not simply clicking-through from the newsletter. It seems the website is starting to stick with our readers.

(b)

After contracts were signed with the MN and ND Department of Agriculture, we began conversations with Pulse Canada about reaching a formal agreement on the use of existing proprietary literature review. Northarvest learned Pulse Canada mere existence was in jeopardy because the Canadian government had not provided funds to continue supporting their existence. Secondly, we learned their point person on this area of expertise was no longer with them. So given those circumstances and in consideration to the minimal amount of money designated to this project Northarvest decided to designate oversight on this project to Communiqué and they reported directly to Northarvest. The review of the existing scientific research was conducted by Dr. Mark Messina who is, in Communiqués estimation, the world's leading authority on health research related to soy and he is also very interested in the dry bean.

Since Pulse Canada was not a part of this project, we needed to start at the beginning instead of being able to expand on their information. In doing so, we were unable to report on the following: update and re-evaluate the status of literature on the linkage between consumption of dry beans and serum glucose response, updated literature review in form appropriate to regulatory review, and consultant recommendation on statement form, content, and methods of procedure.

Dispite the challenges of not contracting with Pulse Canada, the goals of this project have not changed. We intend to update and re-evaluate the status of literature on the linkage between consumption of dry beans and serum glucose response, update literature review in form appropriate to regulatory review, and engage consultant to advise Northarvest on steps and actions necessary to appropriately prepare structure-function claim.

Even though there were some difficulties at the beginning of this subproject, we fully intend to further our research using money from our own organization.

The investigation did find the following results:

Resistant Starch in Beans Could Improve Satiety

Beans are a rich source of resistant starch, a type of starch that is similar to dietary fiber in that it is not digested by intestinal enzymes. Since fiber has been shown to help people feel more full after a meal, British researchers hypothesized that resistant starch would have the same effect. They gave a supplement of either resistant starch or a placebo to young healthy male subjects at both breakfast and lunch. When the men consumed the resistant starch supplement, they ate about 90 calories less at a subsequent test meal later in the day and also consumed fewer calories over the whole 24-hour period. Consuming more resistant starch resulted in a smaller insulin response after meals, too, which may affect hunger. This research suggests that eating foods rich in resistant starch, like beans, could help reduce caloric intake.

A**mericans Don't Consume Enough Legumes**

Since the 1980's, the U.S. Department of Agriculture has issued and updated the Dietary Guidelines for Americans every five years. But are Americans eating more healthfully as a result of that guidance? Researchers from the National Cancer Institute say that the answer is "no." They analyzed data regarding the American food supply and found that there was little improvement in dietary quality between 1970 and 2007 and that diets continue to fall far short of the guidelines. In short, Americans consume too much fat, added sugar and alcohol and not enough nutritious food. They suggested that Americans need to eat much more fruit and whole grain products. And to achieve optimal diets, vegetables need to increase by 70 percent with nearly all of the increase coming from dark green vegetables, orange vegetables, dry beans and other legumes.

Beans Help with Weight Loss and Lower Chronic Disease Risk

Obese people have higher levels of biological markers of inflammation. This low grade chronic inflammation may raise risk for atherosclerosis, diabetes, and hypertension. Weight loss can reduce inflammation and a new study shows that eating more beans may do so, too. Spanish researchers placed two groups of subjects on low calorie diets. One group consumed no more than a serving of beans per week and the other group included four bean servings per week in their menus. (Average consumption in Spain is around two servings of legumes per week.) At the end of eight weeks, people in both groups lost weight but weight loss was greater in the subjects who ate more beans. This group also had a bigger drop in some inflammatory markers. Even after the researchers controlled for the effects of weight loss on these markers, subjects who ate beans had less apparent inflammation. A number of factors in legumes could help explain their benefits for weight loss and reducing inflammation, including their high fiber and magnesium content, and array of phytochemicals. The findings show that eating more beans can help overweight people lose weight and also protects against chronic disease in additional ways.

Bean-Fortified Spaghetti Has a High Protein Content and Low Glycemic Index Carbohydrates that are quickly digested and absorbed have a high glycemic index (GI), causing rapid spikes in blood glucose. Low GI foods release glucose more slowly and gradually into the blood. Diets based on low-GI foods are associated with a reduced risk for diabetes and other chronic diseases. While fiber rich foods tend to have lower GIs, some refined products, such as spaghetti, also cause a relatively slow release of glucose into the blood. Since spaghetti is typically low in nutrients and especially protein, Mexican researchers created a more nutritious product by fortifying it with flour made from beans. Not only did the addition of beans boost the protein content of the spaghetti, but it also lowered its GI even further. (Like other protein-rich plant foods, beans typically

have a low GI.) This research shows that spaghetti made from a combination of the usual semolina flour plus beans is a good way to increase protein intake and reduce the GI of diets.

c)
The NCAUR goals were to (1) isolate and identify the range of polyphenolics in beans, (2) conduct literature reviews to compare antioxidant capabilities, (3) establish database of phenolic compounds and their properties, (4) isolate and characterize TCA fractions from beans**,** (5) determine bile-binding capacities of isolated compounds, (6) Characterize physical and select functional characteristics of bean starches, and (7) determine comparative hydrologic properties of starches. The outcome showed NCAUR was able to complete the research on the first 3 goals, goals 4 and 5 were not yet completed and goals 6 and 7 are complete and involved extension of research beyond that originally proposed.

The synopsis of activities for the first goal involved isolating and identifying the range of polyphenolics in beans. We employed the microwave-assisted extraction method in this study and found this method to be effective in extracting phenolic constituents from eight bean types. The total phenolic contents determined by this extraction method with water at 100°C were 2-3 times those obtained by conventional extraction with water at the same temperature.

Goal two involved the study of antioxidants of 8 beans. Since phenolics correspond to one of factors responsible for antioxidant property of beans, the analysis of antioxidants in the microwaved extracts were carried out. It was found that microwave-assisted extraction method gave results that depend on extraction temperature; as a result, a correlation between total phenolics and antioxidant property was not found. On the other hand, the conventional heat extraction gave a fair correlation between total phenolic and antioxidant property.

From the work done at Peoria, several procedures were established to extract phenolic compounds and antioxidants from beans. A literature survey has shown that the phenolic compounds in beans consist of at least 5 types: flavonols, glycosylated flavonoids, trans-hydroxycinnamic acids, anthocyanidins, and anthocyanins. All eight beans supplied by Northarvest (navy, pinto, light red kidney, black, dark red kidney, great northern, pink, and small red beans) contain hydroxycinnamic acid and its derivatives. Pinto, light red kidney, black, dark red kidney, pink, and small red beans contain flavonols. Only black and small red beans contain anthocyanins and anthocyanidins. The information has been entered into a spreadsheet as the start of a database on phenolic compounds.

The activities for goals 4, 6, and 7 include bean oils. Because of the much lower amount present, the study of triglyceride oils in common beans and their nutritional benefits has usually been overlooked. The four whole common beans included dark red kidney, black, pinto, and great northern beans. We evaluated the oils of these four beans for their chemical composition including fatty acid profile, tocopherol content, oxidative stability and other physical properties. These bean oils are interesting in that they contain high levels of polyunsaturated fatty acids responsible for high iodine value, and at the same time they also contain very high levels of tocopherols (and other antioxidants) which may be responsible for their high oxidative stability.

Goals 6 and 7 involve both bean extrusion and ethanol production from bean. The common extrusion equipment “Brabender” we have in our facility was successfully used to provide a combination of high-temperature, pressures and shearing-stress for cooking the defatted whole beans. Thus far, relatively few investigations have been done on whole-seed common beans due to the difficulty of extrusion operation. Yet, in this study, we determined the physicochemical and functional properties (e.g., color, water solubility, oil absorption capacity,

total starch, starch digestibility, etc.) of extrudates of four defatted-whole common beans as a function of extrusion temperature, feed moisture, screw speed, and other variables.

Dry common beans (*Phaseolus vulgaris* L.) were evaluated for potential conversion of starch to ethanol. Eight varieties of beans with average starch content were assayed in a laboratory-scaled process based upon the commercial corn dry grind fermentation process. The average ethanol yield for the eight bean type demonstrated that starch from beans could be efficiently converted to ethanol.

The postdoc who did the earlier work on goals 4 and 5 received an offer from a different research unit before the goals were finished; because of this changeover and not being able to find a replacement in time, the goals were not fully completed. These two goals are being researched further and NCAUR will have a replacement in 2012 to take over and finish the work that was started. That work will be funded utilizing Northarvest Bean Association funds.

The work on extraction of phenolics and antioxidants has been incorporated into two manuscripts, one in print and one submitted for publication. The principal investigator has plans to write a review article on the work done on beans. The information on phenolic compounds will be part of the review article.

NCAUR ended up with two published manuscripts, one manuscript under review, and two manuscripts nearly completed and ready for submission.

List of manuscripts/publications and their status;

1. Nongnuch Sutivisedsak, Bryan R. Moser, Brajendra K. Sharma, Roque L. Evangelista, Huai N. Cheng , William C. Lesch, Robert R. Tangsrud & Atanu Biswas. Physical Properties and Fatty Acid Profiles of Black Bean, Kidney Bean, Great Northern, and Pinto Seed Oils. Accepted for publication in Journal of American Oil Chemist's Society.

2. Sutivisedsak, N., Cheng, H. N., Willett, J. L., Rose, D., Lesch, W. C., Tangsrud, R. R., & Biswas, A. Extraction and Analysis of Antioxidant Capacity in Eight Edible Beans. To be submitted to Journal of Agriculture, Food and Environment.

3. Sutivisedsak, N., Singh, M., S. Liu, Cliff Hall and Biswas, A. Functional/Physical Properties of Four Common Bean (*Phaseolus vulgaris* L.) Extrudates. To be submitted to Journal of Food Science.

4. Nichols, N. N., Sutivisedsak, Dien, B. S., Biswas, A., Lesch, W. C., Cotta. M. A. Conversion of starch from dry common beans (*Phaseolus vulgaris* L.) to ethanol. Submitted to Industrial Crops & Products.

5. Sutivisedsak, N., Cheng, H.N., Willett, J.L., Tansgurd, R., Lesch, W.C., Biswas, A. Effect of Microwave Extraction on Phenolic Content of Beans. Food Research International. Volume 43, Issue 2, 516-519. 2010.

Beneficiaries

(a)

The 40,000 dieticians that were mailed a hard copy of DBQ are in an educated position to help the consumer make smart choices for a healthier lifestyle. Ultimately, this will result in an increase in the awareness level and use of beans in healthy diets among consumers. Influencing the influencer is an affordable way for the growers to expand usage.

(b)
Once a structure-function claim is identified, the FDA will be able to review. If the FDA allows use of the claim for use by the trade in labeling and advertising of dry beans to consumers, it will increase consumption and awareness. The four major canneries and three major packing outlets are the biggest operations that will benefit through the success of this project. Ultimately, every person in the United States is able to benefit from this project through awareness and consumption.

(c)
The beneficiaries of this project, once completed, will be the bean producers, nutritionists, and manufacturers of nutraceutical products. The bean producers will benefit from the knowledge of the added nutrition value of the beans, which will hopefully stimulate increased consumption of beans. There are over 10,900 U.S. dry beans producing farms that will benefit along with approximately 60,000 nutritionists and dieticians in the U.S. who will benefit from the completion of this project. With the evidence growing that the polyphenolics in beans have useful nutritional and pharmacological properties, they can be useful as healthy food supplements and as nutraceuticals in health food stores. The current work shows that different methods of extraction may produce different amounts of phenolic compounds and antioxidants, which would be useful to those who try to maximize the amount of extractables from beans.

Lessons Learned
(a)
Northarvest learned this subproject requires many professional and accredited individuals to be involved in the process. Dieticians as a whole are aware of beans and their health attributes but needed the tools in order to tout the health benefits. Dry Bean Quarterly draws visitors to the website. BeanInstitute.com was largely unnoticed during its first months, with the big exception being the days that an issue the newsletter was released. BeanInsitute.com now has a sixty percent increase in the number of visitors, and the website is becoming established in the minds of users as a health resource.
(b)
We learned there is limited existing research from which to draw from that may lead to a health related statement that will ultimately stimulate greater bean awareness. We further conclude that in order to move forward to determine if any of the research discoveries can even qualify as a health related statement , it would require additional time and funds that cannot be covered under this agreement.
(c)
As with most research, there remained some gaps and Northarvest commissioned NCAUR to continue with some additional research ending February 2013. We plan to continue screening the eight beans to identify promising components.

This was a multi state grant and 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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Final Report

Specialty Crop Block Grant Program

North Dakota Department of Agriculture

Local Foods Initiative

June 2011

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Table of Contents

Project Summary	Page 3
Project Approach	Page 3
Goals Achieved, Outcomes, and Beneficiaries	Page 3
Lessons Learned	Page 7
Addendums A-F	Page 9

Project Summary

The North Dakota Department of Agriculture received Specialty Crops Block Grant dollars to increase awareness and consumption of local foods, specifically fruits and vegetables, through a Local Foods Initiative. We have seen strong and positive response in the first three years of the North Dakota Local Foods Initiative.

The Going Local North Dakota Initiative's vision is to create a food system in North Dakota that is abundant in locally produced foods to foster the betterment of our health, economic well being and the self reliance of our citizens.

There are more than 55 farmers markets and at least nine CSA (community supported agriculture) programs now operating in North Dakota. Those numbers are on a steady up-swing as people are understanding the many benefits that growing, consuming and connecting with local growers brings to our communities and our way of life.

North Dakota now has over 10 communities that continue to work on individual projects and planning to help promote local foods in their area. Coordination, education, networking and technical assistance are needed now, more than ever, to raise these efforts from planning stages into measurable successes.

The North Dakota Department of Agriculture utilizes many avenues to promote the local foods movement across the state. In order to ensure specialty crop grant money is utilized for the sole purpose of specialty crop development, the NDDA employs three marketing specialists. One specialist, funded through this grant, works solely with specialty crop promotion and production. The other two specialists work with the North Dakota Farmers Market and Growers Association and the 165 Pride of Dakota food companies to help promote local foods in the state. Matching funds were used from the North Dakota Department of Agriculture to fund non-specialty crop initiatives by using the two specialists not funded through this grant.

The activities funded through this project include:

- Farm to school project-
  - Jamestown Public School
  - Valley City Public School
  - Granville Public School
  - Youth Correctional Center in Mandan
  - Grand Forks Public School
  - Hazelton Public School
  - Fessenden Bowdon Public School

- CSA's -
  - 4 Seasons CSA – Bottineau
  - North Star Farms – Carpio
  - Tangle Tree Ranch – Doyon
  - Riverbound Farm – Mandan
  - Baskets of Plenty – Mandan
  - Llama Trax Gardens – Valley City
  - A Plus Farm Produce – Kindred
  - Morning Joy Farm – Cleveland

- Videos
- Hunger project
- Orchard- creation of manual; on web site; and
- Humanities- large project by the Humanities Council. Our portion was for emphasizing on fruits and vegetables.

This report is a complete synopsis of the Going Local Initiative, including those activities that were not funded with specialty crop grant dollars.

Project Approach

The Going Local – North Dakota Local Foods Initiative was started by the Department of Agriculture in 2008. This program was started to inspire and equip North Dakota communities with the potential to begin growing, supporting and consuming local foods.

Goals Achieved

The overall goal of the Local Foods Initiative is to increase consumption and consumer awareness of North Dakota's local fruits and vegetables.

Specific goals include:

1. To increase the number of schools in the national Farm to Cafeteria from zero to five with a minimum of three within the next school year.
2. To promote local foods through the use of video "Face of the Farmer" promotion with a minimum of seven videos available for use by anyone serving local foods at no expense for copies.
3. To begin mobile processing, furthering the information learned from the last grant.
4. To utilize any remaining time, personnel, and lease on the mobile food processing unit to glean crops such as apples or potatoes, or accept donations from local gardeners to process and donate to the Lutheran Social Services Great Plains Food Bank for distribution to North Dakota residents in need.

The NDDA feels the Local Foods Initiative and goals set forth through the specialty crops program has been a great success. The information presented in this report showcases that our goals and efforts have been met. We continue to work the local foods plan in North Dakota as local foods, regionally and nationally, continue to evolve with new and fresh ideas.

Local foods initiatives by the NDDA have been perceived as a positive movement by the state in renewing small communities through new and improved economic and social activity.

Expected Outcomes, Results and Beneficiaries

1. *Become recognized as a Farm to Cafeteria state, and use the Minnesota toolkit for schools as a model. Target three schools that are currently working on acquiring local foods and working with the Midwest representative for Farm to Cafeteria. This project worked exclusively on the production and promotion of fruits and vegetables in schools.*

North Dakota has been identified as a leader in the upper Midwest states by the Center for Rural Affairs in furthering farm to school programs in the state. We have received recognition from the national Farm to School organization and our state has been added to those with farm to school programming.

Because of our association with the national organization, a state leader was identified to be part of a regional farm to school team in the Midwest region which includes: North Dakota, South Dakota, Nebraska, Kansan, Iowa, Missouri and Oklahoma.

The state hosted two farm to school workshops in conjunction with the Center for Rural Affairs, Lyons, Neb., and we have a representative that meets once a month with the regional team leaders via conference call. The group met three times during the national farm to school conference in Detroit, Mich., in May 2010.

Press on the new programs in the state can be found at http://www.farmtoschool.org/ND/media.htm.

The North Dakota governor's office proclaimed North Dakota's first Farm-to-School Week Sept. 20-24, 2010. The schools were encouraged to do at least one event that week to promote local foods. We have the support of the ND Department of Public Instruction and the ND Department of Health. North Dakota will proclaim September 19 – 23, 2011 as Farm-to-School week. We will also continue to promote local products by proclaiming October 4, 2011 as Pride of Dakota Day in the schools where institutions will again feature North Dakota grown and produced products through their lunch program.

2. *Produce seven videos, approximately one to two minutes each that can be used by schools, colleges, restaurants, institutional lunch services, grocery stores, and farmer market managers to promote specialty crops. These videos will exclusively promote fruits and vegetables.*

The department was able to identify seven farmers and business professionals to be marketed through videos. Seven producer videos were created to put "a face to the farmer" in local grocery stores, restaurants, schools and college lunch rooms, web-based promotions, and farmers markets.

The videos highlighted restaurants, stores, farmers market sales and direct marketing of fruits and vegetables throughout North Dakota in an effort to tell the story of local products and local people. We picked people we felt impacted local foods in our region and we feel the videos will help encourage people to connect with local producers and buy locally grown and produced products.

We supplied copies of the videos and portable dvd players to the "stars" to use in their marketing and business efforts. The videos were also posted to Facebook and we started a YouTube channel to make the videos available on the web.

Stores and growers involved with the project include:

Riverbound Farm: CSA - Mandan, ND

North Star Farms: Farmers market producer, farmers market manager, organic CSA – Carpio, ND

The Pirogue Grill: Locally owned restaurant featuring locally grown foods – Bismarck, ND

Home Sweet Home: Retail store featuring locally grown products – Minot, ND

Red Barn and Berry Farm: U-pick raspberry farm – Kindred, ND

Arrowhead Plaza Drug: Drug store featuring locally grown products – Bismarck, ND

Dan's Supermarket: Grocery store featuring locally grown produce and products – Bismarck & Mandan, ND

Beneficiaries of the project include the seven highlighted video spots plus the thousands of potential consumers that will hear the story and connect with the farmer and local foods across the state.

3. *Lease and utilize the mobile food processing center to work with three schools in extending their use of local produce through preservation and storage for winter months.*

Extending the season in three active school lunch programs by leasing the mobile food processing unit, the result of a prior local foods grant study, to preserve produce for use in winter months.

Locally grown corn-on-the-cob was processed in the mobile food unit and served in lunch programs in 10 North Dakota schools over the winter.

The North Dakota Department of Agriculture acquired a mobile food processing unit as of August 2010. Work began immediately to identify opportunities for this commercial kitchen on wheels to provide the ability to quickly freeze produce for schools to use in the winter.

The NDDA partnered with NDSU Extension Service to blanche and freeze several thousand servings of corn-on-the cob to utilize during winter months for the farm to school program.

Over 10 schools were chosen to serve the corn in their school lunch program.

The corn brought attention to the farm to school program and generated media attention and positive response from the school administration, faculty and area growers. Ten schools received corn, reaching 2,000 students, faculty and staff.

4. *Do research and prepare a manual on How to start a Community Orchard in Your Community. This manual will include the agronomic as well as the organizational and financial aspects of establishing community fruit orchards. As the planting of alternative crops becomes a common trend in North Dakota, growers seek the guidance and tolls necessary to bring complex practices, like a community orchard, to life.*

A *How to start a Community Orchard in Your Community* manual was generated through funds from the specialty crops block grant in partnership with NDSU Extension Service.

The local foods initiative helped create awareness in the need for additional fruit opportunities across the state. With the out migration of small communities in North Dakota, there is space and land available in towns of all sizes to create community orchards for the future. This manual will provide communities and organizations with the necessary information to turn these underutilized lots and pieces of land into thriving and fruit bearing community assets.

The next step of this project will include promoting food preservation for the long winter months while encouraging groups to establish orchards within their communities. Potential beneficiaries of the project include the many communities utilizing the study to provide their citizens and visitors with the access to fresh, local fruits.

5. *Provide a $5,000 sponsorship to the North Dakota Humanities Council to assist in the production of four mini documentaries on food issues in North Dakota.*

A $5,000 sponsorship was provided to help develop food based documentaries on local growers and local issues. The documentaries will be a part of the Key Ingredients traveling exhibit in 2012 – 2013. Six North Dakota communities will have the opportunity to display and educate visitors on local foods history and its future in ND.

Elements of the documentaries include:

a. How local food enhances a sense of community
b. Chronicle the farming practice of saving seed in the region, beginning with the Native farmers and continuing to the present day. This includes:

i. The Native "three-sisters" method of raising squash, beans and corn, as well as Native techniques for saving seed.

ii. How farmers and University personnel are using older varieties and how they are managing their farming operations with an eye toward seed saving.
iii. Community Supported Agriculture (CSAs) as a new model of small-scale efficiency

6. Provide dollars for Food Summit III in February, 2011. Available funds will be used to enhance the Food Summit III Conference.

A third local foods summit took place in February of 2011 bringing education opportunities to North Dakota producers with workshops and time for networking.

The North Dakota Farmers Market and Growers Association partnered with the NDDA to hold a Local Foods Conference highlighting educational sessions and the NDFMGA annual meeting. The meeting was a success and presenters from across the region presented papers and session on local foods tends and opportunities. The Conference was held in Jamestown, ND.

The local foods summit has proven to be a growing venue for residents who are exploring specialty corps on their small farms. The summit was held in Bismarck in February and was attended by more than 140 people.

In summary, groups that benefited from this project included schools that learned about the farm to school (cafeteria) program, thousands of visitors to the farms, restaurants, and retail stores that produced videos about their specialty crop products, the seven entrepreneurs that were actually featured in the videos, the thousands of people who will view the documentaries on local growers through the Humanities traveling exhibit and the actions they take as a result, the scores of communities who can access the manual on *How to Start a Community Orchard in Your Community* and the untold number of people who will benefit from these orchards because of the interest generated from this manual. In addition, it is impossible to gauge the inspiration received from attendees at the Local Foods Conference that resulted in

more producers of fruits and vegetables. It is sufficient to conclude that all of these combined efforts made this project a wise investment towards the goal of enhancing specialty crops in North Dakota.

Lessons Learned:

One item we've learned is the fact that there is an interest in local foods, farming, CSAs, farmers markets and direct marketing in the state. There is also increasing interest in sourcing food locally. With all the publicity around the initiative and information delivered from the NDDA and partners, there has been an increased awareness of the need to continue efforts to bring markets to farmers and farmers to markets. Specific information requested throughout the year, is not limited to health regulations, how to start a business, grant opportunities, how to grow a business and season extension. Interest is also building for Farm to School, cooking and canning classes, community and school gardens.

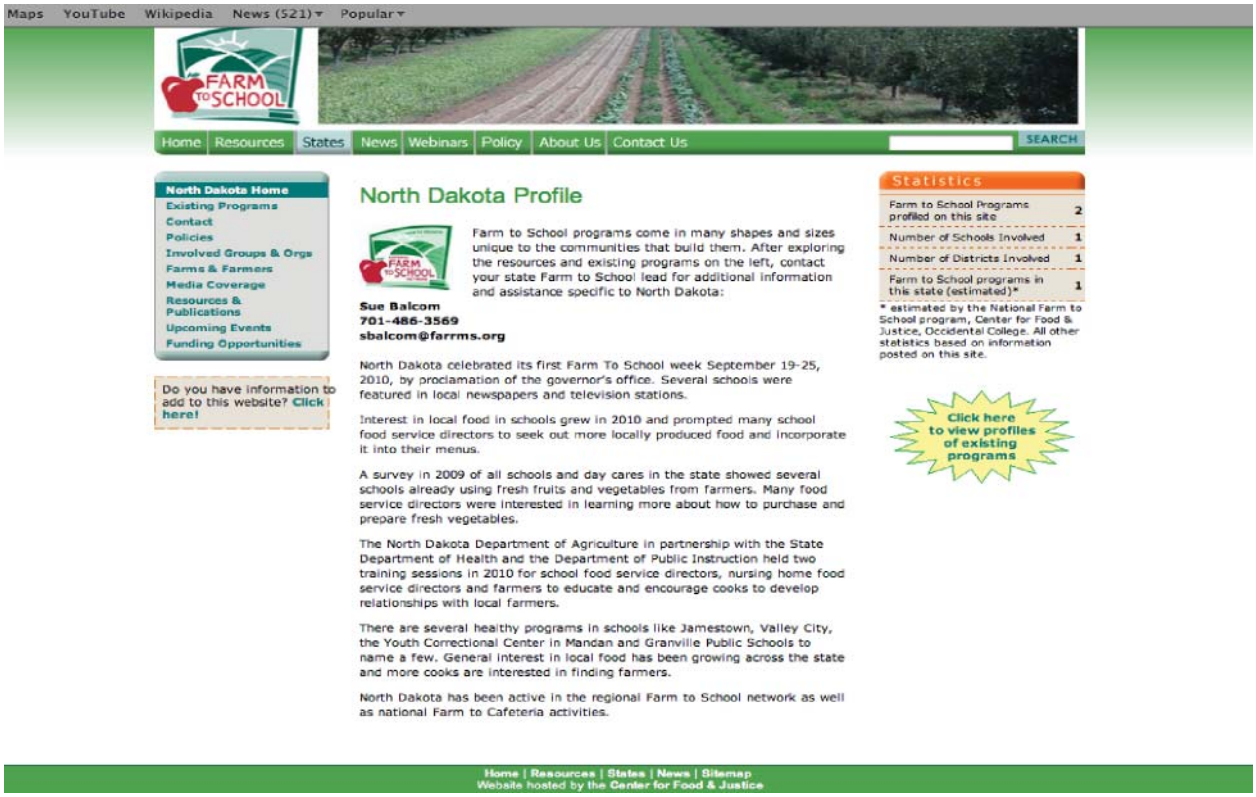
While we had many successes this past year there is still a need to educate and encourage people to understand local foods and the many benefits that come along with a locally based food system. Obstacles are many in coordinating the producing and consuming of local foods. We continue to learn that communication and partnerships are what we need to achieve success.

With that in mind, one of the biggest lessons we've learned is the need to establish a statewide network of folks and partners working on local foods. In order to address this issue North Dakota has developed a Scaling-up Local Foods committee which recently held a Research Symposium to help identify the state's key players and what actions are taking place around the region. The committee is not only identifying the key players and trying to eliminate overlapping duties across the state but, they are also gathering information, pooling resources and collecting data on producers, distribution opportunities and partnership advancements.

While key players are addressing needs and resources across the state we are learning the challenges that exist connecting the producers and consumers together, coordinating schedules and finding a common ground to move forward. These obstacles are items easily dealt with as people understand their role in the local foods movement and work together for the cause.

The NDDA is excited to work through the lessons and challenges within the state and region to strengthen our local foods system. It is an exciting time for local foods, and we look forward to forming connections and overcoming the challenges to grow the local foods movement.

ADDENDUM A – North Dakota's Farm to School Profile



Maps YouTube Wikipedia News (521) Popular

FARM TO SCHOOL

Home | Resources | States | News | Webinars | Policy | About Us | Contact Us | SEARCH

- North Dakota Home
- Existing Programs
- Contact
- Policies
- Involved Groups & Orgs
- Farms & Farmers
- Media Coverage
- Resources & Publications
- Upcoming Events
- Funding Opportunities

Do you have information to add to this website? Click here!

North Dakota Profile

Farm to School programs come in many shapes and sizes unique to the communities that build them. After exploring the resources and existing programs on the left, contact your state Farm to School lead for additional information and assistance specific to North Dakota:

Sue Balcom
701-486-3569
sbalcom@farrms.org

North Dakota celebrated its first Farm To School week September 19-25, 2010, by proclamation of the governor's office. Several schools were featured in local newspapers and television stations.

Interest in local food in schools grew in 2010 and prompted many school food service directors to seek out more locally produced food and incorporate it into their menus.

A survey in 2009 of all schools and day cares in the state showed several schools already using fresh fruits and vegetables from farmers. Many food service directors were interested in learning more about how to purchase and prepare fresh vegetables.

The North Dakota Department of Agriculture in partnership with the State Department of Health and the Department of Public Instruction held two training sessions in 2010 for school food service directors, nursing home food service directors and farmers to educate and encourage cooks to develop relationships with local farmers.

There are several healthy programs in schools like Jamestown, Valley City, the Youth Correctional Center in Mandan and Granville Public Schools to name a few. General interest in local food has been growing across the state and more cooks are interested in finding farmers.

North Dakota has been active in the regional Farm to School network as well as national Farm to Cafeteria activities.

Statistics

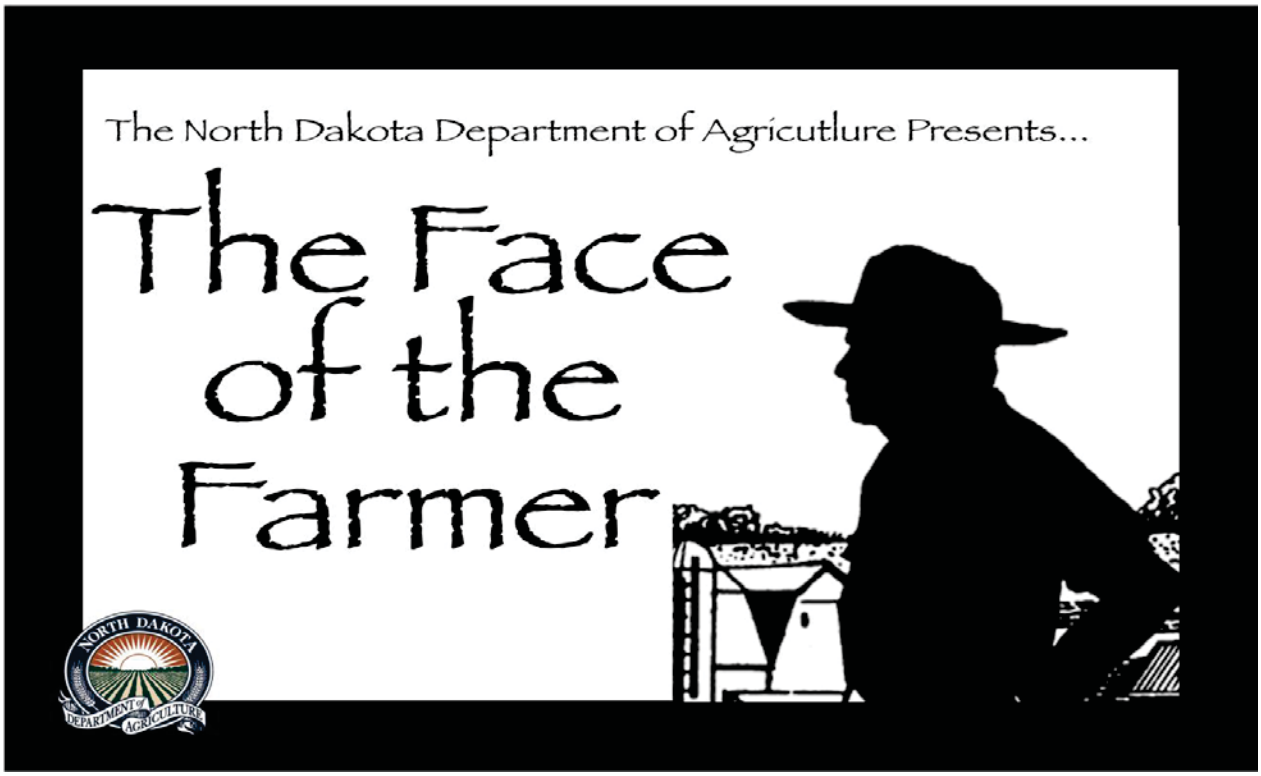
Farm to School Programs profiled on this site	2
Number of Schools Involved	1
Number of Districts Involved	1
Farm to School programs in this state (estimated)*	1

* estimated by the National Farm to School program, Center for Food & Justice, Occidental College. All other statistics based on information posted on this site.

Click here to view profiles of existing programs

Home | Resources | States | News | Sitemap
Website hosted by the Center for Food & Justice

ADDENDUM B – The Face of the Farmer videos



Riverbound Farm: CSA - Mandan, ND

- http://youtu.be/qffQQWNMbow

North Star Farms: Farmers market producer, farmers market manager, organic CSA – Carpio, ND

- http://youtu.be/wDcyxsYdBnc

The Pirogue Grill: Locally owned restaurant featuring locally grown foods – Bismarck, ND

- http://youtu.be/7JpgSCsQLl4

Home Sweet Home: Retail store featuring locally grown products – Minot, ND

- http://youtu.be/PIXMSvRvfZs

Red Barn and Berry Farm: U-pick raspberry farm – Kindred, ND

- http://youtu.be/TUqQvbbjWtM

Aarowhead Plaza Drug: Drug store featuring locally grown products – Bismarck, ND

- http://youtu.be/jG0WE28cdfE

Dan's Supermarket: Grocery store featuring locally grown produce and products – Bismarck & Mandan, ND

- http://youtu.be/5Z1XbUr69-I

ADDENDUM C – Lease and utilize the mobile food processing center to work with three schools in extending their use of local produce through preservation and storage for winter months.

School Lunch Program	Served
Elgin Public School	150
St. Anne Catholic School	200
Harvey Elementary School	300
Harvey High School	150
Hurtsfield Public School	25
Fessenden/Bowdon Public School	125
Napoleon Public School	300
St. Mary's Catholic School	250
Granville Public School	175
Towner Public School	225
Total	

Below: Harvey Public School students help serve locally grown and processed corn-on-the-cob during school lunch. **Right:** Locally grown corn in the school lunch line at St. Mary's Catholic School, Bismarck, ND

ADDENDUM D – Starting a Community Orchard in North Dakota Manual

Starting a Community Orchard in North Dakota

Produced in cooperation of the North Dakota Department of Agriculture and the USDA Specialty Crop Grant Program

NDSU Extension Service

Starting a Community Orchard in North Dakota

Table of Contents

Chapter 1. Introduction 1

Chapter 2. Starting Your Orchard
- Selecting your site 2
- Preparing the land 3
- Buying plants 3
- Planting 4
- Pruning 5
- Fertilizing 5
- Watering 5
- Mulching 5
- Staking 5
- Trellising 6
- Wrapping and painting 6
- Managing wildlife 6
- Spraying 7
- Pruning and training young trees 8
- Rejuvenating old apple trees 10

Chapter 3. Fruits for North Dakota

Tree Fruits
- Apple 11
- Apricot 13
- Cherry 13
- Cherry plum 14
- Crabapple 14
- Peach 15
- Pear 15
- Plum 16

Small Fruits
- Aronia 17
- Blackberry 17
- Blueberry 18
- Bush Cherry 18
- Currant 19
- Elderberry 19
- Gooseberry 20
- Grape 20
- Honeyberry 21
- Juneberry 21
- Raspberry 22
- Rhubarb 23
- Seaberry 23
- Strawberry 24

Chapter 4. Starting Your Organization
- Structure 25
- Liability 26

Chapter 5. Community Orchard Projects
- United States 27
- United Kingdom 34

Chapter 6. Ten Steps to a Community Orchard 36

Appendixes
1. Sources of Plants and Supplies 38
2. Sample Budget 39
3. Funding Opportunities 40
4. Sample Contract for Land Use 42
5. Sample Bylaws 43
6. Sources for Technical Advice 45

Literature Cited and Photo Credits 46

NDSU
Extension Service

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County Commissions, NDSU and U.S. Department of Agriculture Cooperating. This publication will be made available in alternative formats for people with disabilities upon request, (701) 231-7881.

For a complete copy of the orchard project visit:

http://www.agdepartment.com/PDFFiles/CommunityOrchardManual.pdf

ADDENDUM E – Sponsorship dollars for the North Dakota Humanities Council press release from the Bottineau community.

Smithsonian Exhibition Tours North Dakota and Bottineau

Dakota College and the Bottineau Technology Center, in cooperation with the North Dakota Humanities Council, will host the local showing of *Key Ingredients: America by Food,* a Smithsonian Institution traveling exhibition which delves into the historical, regional and social traditions that merge in everyday meals and celebrations of the American table. The exhibition will be on view beginning December 8, 2012, and continuing through January 20, 2013, and will give Bottineau an opportunity to celebrate the regions food heritageThe exhibition will be displayed at the Bottineau Technology Center.

Dakota College, the Bottineau Technology Center, and the surrounding community have been expressly chosen by the North Dakota Humanities Council and the Smithsonian Institution to host *Key Ingredients* as part of the Museum on Main Street projecta national/state partnership to bring exhibitions and programs to rural cultural organizations. The exhibition will tour six communities in North Dakota from October, 2012, through August 2013.

Through a selection of artifacts, photographs and illustrations, *Key Ingredients* examines how culture, ethnicity, landscape and tradition influence the foods and flavors we enjoy across the nation. The exhibition looks at the evolution of the American kitchen and how food industries have responded to the technological innovations that have enabled Americans to choose an ever-wider variety of frozen, prepared and fresh foods.

An interactive website, www.keyingredients.org, has been developed in conjunction with the exhibition. The site invites people across the country to share their family recipes and food stories, learn about other food traditions and identify favorite small town eateries.

"We are very pleased to be able to bring *Key Ingredients* to our area," said Tim Davis, Event Coordinator. "We hope that it will inspire many to become even more involved in the cultural life of our communit^{y}."

"Allowing all of our state's residents to have access to the cultural resources of our nation's premiere museum and community conversations on these key issues is a priority of the North Dakota Humanities Councl," said Brenna Daugherty, Executive Director of the North Dakota Humanities Council."

Key Ingredients is part of Museum on Main Street, a unique collaboration between the Smithsonian Institution Traveling Exhibition Service (SITES), state humanities councils across the nation, and local host institutions. To learn more about *Key Ingredients* and other Museum on Main Street exhibitions, visit www.museumonmainstreet.org. Support for Museum on Main Street has been provided by the United States Congress and the North Dakota Humanities Council.

SITES connects millions of Americans with their shared cultural heritage through a wide range of art, science and history exhibitions. State humanities councils, located in each state and U.S. territory, support community-based humanities programs that highlight such topics as local history, literature and cultural traditions.

END

ADDENDUM F – agenda for the Local Foods Summit II

Dakota Grown

A local foods conference

February 19 and 20, 2010
Gladstone Inn - Jamestown
www.gladstoneinn.com

Friday, February 19

8 - 8:30 a.m.	Registration Desk Open
8:30 - 9 a.m.	Welcome & Introductions
9 a.m. – 11 a.m.	Key Note Speaker – Ken Meter with morning break
11 – 11:30 p.m.	Q & A with Ken Meter
11:30 - 12 p.m.	ND Local Foods Initiative Update – Sue Balcom Community Surveys, directory and Farm to School
12:00 - 1:00 p.m.	Soup Kitchen Lunch & Networking

Choose your session:	Growing	Marketing
1 p.m.	Organic Pest Control *Ron Smith*	Selling Local Locally *Noreen Thomas*
2 p.m.	Rural Grocers Initiative *David Procter*	Social Media & You *Ms Marlo Miller, TrainND*
3 p.m.	Square Foot Gardening *Betsey Smith*	Volunteerism – Engaging your Community for the long term *Denis Monplaisir, Medora Foundation*

4 - 6 p.m.	North Dakota Farmers Market & Growers Assn. Business Meeting
6 – 6:30 p.m.	Social
6:30 p.m.	Dinner & Keynote Speaker – Ken Meter
7:30 p.m.	Film Viewing FRESH & conversation

$25 *registration fee (meals included)*
Pre-register today to reserve your space at the conference.

The general public is encourged to attend Friday evening's dinner with Ken Meter and the viewing of "Fresh - the movie" exclusive of the conference for $25 per person.
Everyone is encouraged to attend this part of the event and to stay afterward for the discussion.
SPACE IS LIMITED - so don't delay.

Dakota Grown

A local foods conference

Saturday, February 20

7:30 – 8:30 a.m.	NDFMGA board meeting & breakfast
8 - 9:30 a.m.	Table top networking & breakfast
9:30 - 10 a.m.	A word from NDFMGA President Patti Patrie *Introduction of NDFMGA board members* *Presentation of Strategic Plan*
10 - 11 a.m.	ND Projects Presentations *Nola Storm – ND Community Gardens (tentative)* *Chuck Fleming – ND Mobile Kitchen Update* *Sue Balcom - Farm to School*

Choose your session:	**Growing**	**Marketing**
11 a.m.	Post Harvest Handling *Sam Beattie, ISU Extension*	Agri-tourism in North Dakota *Sara Otte Coleman, ND Tourism*
12 p.m. – Lunch & networking		
1 p.m.	Permaculture *Becky Schnabel*	The Case for Farm to School *Sue Balcom and panel*
2 p.m.	GAP & Record Keeping *Sam Beattie, ISU Extension*	Marketing in Today's Economy *Annie Carlson*

3 p.m.	CSA Panel - Hear the stories of North Dakota's CSAs *Jay Basquiat, Baskets of Plenty CSA* *Annie Carlson, Morning Joy Farms* *Marv and Ilene Baker, North Star Farms*
3:45 p.m.	Conference Wrap-Up

Name: _____

Phone: _____ E-mail Address: _____

Address: _____

Number attending: _____ @ $25 per person (includes all events and meals) = $_____Enclosed

Please make checks to NDFMGA and mail to

ND Department of Agriculture
Attn: Dakota Grown local foods conference
600 E. Blvd. Avenue #602
Bismarck, ND 58505-0200
or e-mail registrations to suebalcom@nd.gov or ssinner@nd.gov.

A block of rooms has been reserved at the Gladstone Inn. Call 701-252-0700 to book your room today.

Dakota Grown

A local foods conference

February 19 and 20
Gladstone Inn - Jamestown
www.gladstoneinn.com

Register today... don't miss our keynote speaker and these informative workshops

Ken Meter
Crossroads Resource Center

Dakota Grown's keynote speaker is Ken Meter, executive director of Crossroads Resource Center in Minneapolis. Meter had a previous life as an independent journalist covering food and trade issues. His pioneering work on food systems and the economics of food makes him one of the top food system analysts in the U.S.

Meter's "Finding Food in Farm Country" studies galvanized local foods activity in 45 regions in 20 states, and in one Canadian province. An international leader in sustainability measurement, he directed the public process for the award-winning Minneapolis sustainability plan.

He also specializes in systems work, serving as an associate of Human Systems Dynamics Institute. You can learn more about his work at http://www.crcworks.org/econ.html

Follow us on Twitter with the hash tag #goinglocalnd

E-mail ssinner@nd.gov or suebalcom@nd.gov for more information or to register....

WORKSHOPS INCLUDE:

Organic Pest Control - *Ron Smith*

Rural Grocers Initiative - *David Procter*

Square Foot Gardening - *Betsey Smith*

Real Life Marketing of Local Foods - *Noreen Thomas*

Social Media & You - *Ms Marlo Miller, TrainND*

Volunteerism – Engaging your Community for the Long Term - *Denis Monplaisir, Medora Foundation*

Post Harvest Handling - *Sam Beattie, ISU Extension*

Permaculture - *Becky Schnabel*

GAP & Record Keeping - *Sam Beattie, ISU Extension*

Marketing in Today's Economy - *Annie Carlson*

The Case for Farm to School - *Sue Balcom and panel*

Agri-tourism in North Dakota - *Sara Otte Coleman, ND Tourism*

$25 *registration fee (meals included)*
Pre-register today for the Dakota Grown Local Foods conference.

The general public is encourged to attend Friday evening's dinner with Ken Meter and the viewing of "Fresh - the movie" even if not attending the conference (Cost for dinner/movie $25.)

Everyone attending the conference is encouraged to join us at the movies and and to stay afterward for the discussion.
SPACE IS LIMITED - so don't delay.

Welcome to the Dakota Grown local foods conference

FRIDAY, FEBRUARY 18

8:30 – 9 a.m.	Welcome and introductions
9 – 11 a.m.	Keynote speaker - **Michelle Wall, Dale Carnegie**
11 - 11:15 a.m.	Break with refreshments
11:15 a.m. - 1 p.m.	Lunch - The mobile food processing unit and your community in 2011 ND local Food Initiative update and plans for 2011

SESSION	HOOP HOUSES	GROWING YOUR BUSINESS
1:15 – 2:30 p.m.	Hoop house I - construction **Terry Nennich - U of Minnesota**	Funding, development and how to start a business **Glenn Muske, NDSU Extension**
2:30 p.m.	Break with refreshments	Break with refreshments
2:45 – 3:45 p.m.	Hoop house II - weeds and insects **Terry Nennich - U of Minnesota**	Marketing alternative products panel **Patty Patrie, Bowdon; Kristi Wirrenga, Adrian;** and **Tracie Thompson**, Antler
4 – 5 p.m.	Hoop house III - water/fertility **Terry Nennich - U of Minnesota**	Product pricing **Holly Mawby, Entrepreneurial** Center for Horticulture

5:15 – 6 p.m.	ND Farmers Market and Growers Association business meeting
6 – 6:30 p.m.	Social
6:30 p.m.	Dinner and keynote speaker - **Chris Young, The** Rainmaker Group - committed to helping those we serve make their difference in the world

SATURDAY, FEBRUARY 19

7:30 – 8:30 a.m.	NDFMGA board meeting and breakfast
8 – 9 a.m.	Breakfast - Report on local foods strategic planning in communities: **Bruce Smith - Montana update**
9 – 9:15 a.m.	A word from Karen Gehrig, NDFMGA president

SESSION	ROOTS & STEMS	GROWING YOUR BUSINESS
9:30 – 10:30 a.m.	Heirloom seeds **Theresa Podoll, Fullerton**	CSA I - types of CSAs **Jay Basquiat, Mandan and Annie Carlson, Cleveland**
10:45 – 11:45 a.m.	Plants and seeds – How many plants do I need? Seed supply companies and varieties that do well here **Tom Kalb, NDSU, Bismarck**	"Why should I care about local food?" **Lisa Kyes - Urban Harvest, Bismarck**
12 – 1 p.m.	Lunch - **Bruce Smith - Ag Marketing Cooperative**	
1:15 – 2:15 p.m.	Mulching and composting What is a no-till garden? **Marvin Baker, Carpio**	School garden panel – Farm to School **Sue Balcom - regional Farm to School team, Mandan** **Monica Cox and Lenore Kuntz, YCC-Mandan**
2:30 p.m.	Break with refreshments	Break with refreshments
2:45 – 3:45 p.m.	Natural and non-toxic insect control **Brian McGinness, Mandan**	CSA II - how to build a CSA **Jay Basquiat and Annie Carlson**

3:45 p.m.	Conference wrap -up

Please remember to leave your evaluation forms and name tags at the registration table

Have a safe trip home.... see you next year.

Final Performance Report

North Dakota Specialty Crop Block Grant Program

Northern Plains Potato Growers Association
Chuck Gunnerson
Final Report
Submitted February 2011

Project Title
Managing Potato Early Die Through Potato Breeding Efforts

Project Personnel
Julie Pasche[1], Robert Sabba[2], Asunta (Susie) Thompson[2], and Neil Gudmestad[1]; Departments of Plant Pathology[1] and Plant Sciences[2]; North Dakota State University

Activities Performed
Potato continues to be the most important vegetable and horticultural crop grown in North Dakota and the Northern Plains. The primary pathogen of the early dying syndrome of potato is *Verticillium* wilt, caused by *Verticillium dahliae* Kleb. This fungus affects more than 200 plant species, including many rotation crops and weed species associated with potato production systems. *V. dahliae* survives in soil as microsclerotia, allowing the pathogen to survive long periods in the absence of a suitable host. Populations generally build rapidly, and are well adapted to survival in light, sandy soils commonly used to produce irrigated processing potatoes. Early dying is, by many estimates, the most economically damaging disease of potato in the U.S. when considering both direct losses in yield and quality, and indirect losses due to the cost of control. The only effective control strategy currently available to producers is soil fumigation with metam sodium, a highly toxic and restricted use biocide. Approximately 34 million pounds are applied annually in the U.S. to the soil to kill the microsclerotia and control *Verticillium* wilt, at cost of nearly $170 million, not including the cost of application. Metam sodium recently has been re-registered by the Environmental Protection Agency (EPA), but strict use limitations have been put in place. Metam sodium is expensive and considered a potential health threat.

In 2009, an accelerated effort to develop *Verticillium* wilt resistant cultivars was initiated as a collaborative project between the NDSU potato breeding program (Dr. Susie Thompson, Plant Sciences) with Dr. Neil Gudmestad's research program in Plant Pathology. This effort is in response to producer needs to aid in production of an economically and environmentally sustainable potato crop. In order to develop durable and long-term resistance to pests and stresses, potato breeding efforts continue to include germplasm enhancement to incorporate important pest resistances and improved quality traits via exploitation of wild species and wild species hybrids, in addition to the use of released cultivars and advanced germplasm from around the globe. Breeding, evaluation, and screening efforts are successful because of the cooperative and interdisciplinary efforts amongst the NDSU potato improvement team, the North Dakota State Seed Department (NDSSD), as well as with potato producers, research, and industry personnel in ND, the Northern Plains, and beyond.

Our specific project objective was to develop strategies to manage potato early die in order to reduce input costs, increase potato quality, and reduce pesticide applications. To accomplish this objective, research studies were undertaken in the greenhouse at NDSU and field trials conducted at Inkster, ND, in 2009 and 2010.

Project Approach
Development of germplasm
In 2009, 522 families from true botanical seed were grown in the summer and fall greenhouse crops. Of these families, 26 (5%) included *Verticillium* wilt resistance breeding. In 2010, using traditional hybridizing techniques, 626 new families were created in the greenhouse. Of these, 46, or 7%, included *Verticillium* wilt resistance breeding. The funding provided by this specialty crops block grant provided the necessary resources to allow us to increase the number of families created specifically for this trait. Identifying resistant germplasm and developing durable-host plant resistance to *Verticillium* species are key to releasing superior cultivars for adoption by producers and the potato industry in fresh and processing markets, both important to the ND vegetable crops industry.

Development of screening protocols for utilization by potato breeding and research programs and screening germplasm for resistance
Applying the method of Jansky (AJPR 2009), a replicated trial specific to screening advancing selections (primarily dual-purpose russets) from the NDSU potato breeding program was initiated. Twenty-four and 21 advanced selections and commercial cultivars were evaluated for resistance to *Verticillium* wilt in a trial performed at Inkster, ND in 2009 and 2010, respectively. Two treatments, a control (native soil levels of *V. dahliae*) and an inoculated treatment applied as infested rye in furrow at planting, were used. Agronomic traits, *Verticillium* wilt severity, yield, and grade data were collected for each selection and cultivar in 2009 and 2010. Stem tissue was collected in mid August and again prior to harvest and the pathogen quantified in fresh and dried tissue, respectively, using traditional plating techniques. Dried stem tissue also will be evaluated using the real-time PCR technique detailed below for quantifying pathogen levels in plant tissue. Percentage stand and stems per plant were equal for non-inoculated and inoculated plants (Table 1). In 2009, when these treatments were compared, total yield, US No. 1 yield and percentage, and percentage yield for tubers 4-6 ounces were significantly greater for the native soil *V. dahliae* levels (Table 2). Percentage yield for undersized tubers (<4 oz.), 6-12 oz. and oversized tubers (>12 oz.) were greater for the inoculated plots. Similarly stem sap, mean wilt symptoms, and percentage wilt for the five evaluation dates were all significantly greater than for the native soil level plots (Table 3). Colony forming units (cfu)/g dried stem tissue were not significantly different between non-inoculated and inoculated plots, perhaps verifying the weaknesses of this traditional evaluation method for *V. dahliae* resistance screening. As in 2009, percentage stand and stems per plant were not significantly different when comparing native soil level and inoculated plots (Table 4). In 2010, however, total yield and grade components were not significantly different when comparing these treatments (Table 5). Fresh stem sap quantification and mean wilt symptoms were also not statistically different when comparing treatments, however, clones significantly differed for mean wilt and wilt symptom expression in evaluations from August 9 to September 20 (Table 6).

Additionally, in 2009, 20 members of 110 seedling families with frozen processing potential were grown. Selections without visual wilt symptoms at harvest were retained for future screening. If the screening protocol is successful, seedling selection efforts would mimic somewhat the late blight resistance breeding efforts by the NDSU potato improvement team in terms of acceleration of evaluation from advanced field generations to early generation greenhouse seedling populations, in addition to more rapid production of certified seed.

Quantitative real-time PCR assay for resistance screening A renewed emphasis has been placed on screening cultivars and germplasm for resistance to *V. dahliae* to enhance genetic resistance. Several russet cultivars have been reported to exhibit resistance to Verticillium wilt, but the level of the pathogen was not quantified, possibly due to the extensive time and labor involved in current quantification methods. A quantitative real-time PCR assay was developed that reduces the time and labor required to quantify the *S. tuberosum*:*V. dahliae* interaction. Potato cultivars with purported resistance to *V. dahliae* and susceptible control cultivars (Russet Norkotah and Russet Burbank) were grown in a *V. dahliae* infested research plot described above. Real-time PCR primers and probe developed from the trypsin protease gene of *V. dahliae* were compared to traditional plating methods for pathogen quantification with Pearson's correlation revealing a strong relationship between these assays. The correlation between real-time PCR Ct values and percentage wilt evaluated two weeks after stem sampling also was strong. Real-time PCR successfully amplified the *V. dahliae* in all eight cultivars evaluated including numerous inoculated plants where no *V. dahliae* colonies formed. The results indicate that this PCR assay can be utilized to detect *V. dahliae* in potato stems grown under field conditions and is able to quantify the pathogen in potato plants. Evaluation of plant materials and data from the second year of the field trial currently is underway. Wilt symptom evaluations correspond to observations obtained in the first year of the trial. Additionally, stem colonization results from replicated greenhouse trials support those obtained from the initial field trial. Real-time PCR will provide breeders with the ability to rapidly screen germplasm and distinguish between genetic resistance and tolerance to the pathogen.

In an effort to more precisely and accurately quantify the pathogen using molecular techniques, DNA isolation and PCR assay efficiency must be taken into consideration. One way to accomplish this is the use of a normalizing or reference gene from the host. The potato Actin gene has been utilized for potato pathogen in the past (Atallah and Stevenson, 2006; Atallah et al, 2007), but little analyses were preformed to ensure that this gene is not differentially amplified across cultivars evaluated, as well as, between inoculated and non-inoculated treatments within two cultivars. While no significant differences were observed in the slope and intercepts of regression lines among the eight cultivars represented here, analyses of more cultivars and genotypes should be performed. The use of a normalizing gene differentially amplified across samples, will result in distorted results, depending on the number and types of cultivars evaluated. In a system where only a few cultivars are being evaluated, this may be overcome by including a standard for each, but for breeders evaluating hundreds of genotypes it would not be practical to include a standard for each.

Application of a CAPS marker for adoption as an early generation (MAS) screening tool Marker-assisted selection could be a valuable tool for early generation selection of *Verticillium* resistant genotypes. Qualitative resistance evaluation has been difficult due to differences in symptom expression, tolerance due to little impact on tuber yield, and environmental influence of disease expression. Bae et al. (Mol. Breeding 2008) identified a marker associated with a resistance gene in *Solanum chacoense*. PCR products utilizing F1 and R2 primers from Bae et al. were digested with restriction enzyme NCO-1 for 5 hrs at 37 C. The resulting products were separated by electrophoresis in 2.5% agarose. CAPs marker technology was applied to clones in field trials (Table 7). Resistant genotypes (R) have the 1154 bp band and the associated 1204 bp band present. Just the 1154 bp is present in gels if the genotype is susceptible (S). Four clones have either the 1204 bp band only, or a potential problem with the DNA extracted, and thus their status is unknown. The preliminary results indicate four susceptible and 13 resistant genotypes. ND2858-1 is a derivative of *S. chacoense*; the female parent is an accession of this wild potato species. It was rated as unknown based on the molecular evaluation. Similarly, another line, ND6400C-1Russ, also possessing a source of resistance to Colorado potato beetle, was rated as unknown based on the CAPS marker screening. Both lines would be characterized as resistant based on the screening protocols (Jansky 2009). The cultivar Russet Norkotah also was rated as resistant based on the presence of appropriate marker bands associated with the resistance gene. However, in field evaluations discussed above, Russet Norkotah is clearly susceptible to *V. dahliae*. Thus, this marker associated with the diploid *S. chacoense*, may not be reliable for screening tetraploid *S. tuberosum* genotypes. *Cultivar Release*

AOND95249-1Russ was released as Dakota Trailblazer, in late December 2009. It offers producers and processors *Verticillium* wilt (confirmed by the work summarized above), pink rot, sugar end, and late blight (field) resistance, in addition to outstanding French fry/frozen processing and tablestock properties. Dakota Trailblazer has very high specific gravity, long dormancy, and cold sweetening resistance, processing reliably from 42F (5.5C) storage. In replicated field trials, total yield and quality were maximized at about 180 lbs. N per acre. This is a savings of approximately 70 lbs./acre N when comparing Dakota Trailblazer to Russet Burbank. Dakota Trailblazer is widely used in hybridizing in order to develop *Verticillium* wilt resistant germplasm.

Beneficiaries

Potato producers, potato processing and other potato industry participants, consumers and research programs are the beneficiaries of the reported research. The project has fast-tracked resistance breeding efforts, providing improved lines in the potato breeding pipeline. It has provided more accurate quantification methodology allowing more rapid screening of soil and plant materials. This will permit potato breeding programs in ND and beyond to more quickly quantify colonization. It will also allow potato producers to more accurately determine inoculum levels in fields and base cultivar selection on that information, as well as determine economic threshold levels appropriate for potential fumigation. Consumers and the general public are beneficiaries due to reduced pesticide applications.

Goals and Outcomes Achieved
The PCR assay developed to quantify *V. dahliae* in planta correlates with both wilt severity and with pathogen quantification using traditional plating methods. This assay now provides potato breeders with a powerful tool to evaluate pathogen colonization across genotypes in a rapid manner, therefore, accelerating the timeline for developing cultivars with genetic resistance.

Lessons Learned
It is extremely difficult to prove a pathogen-free control under field conditions and therefore, accompanying greenhouse analyses may be beneficial. Due to the nature of the plant:pathogen interaction, field inoculation procedures are continually being evaluated to provide infection frequency. While the PCR assay outlined above provides a reliable method of pathogen quantification, to ensure that the precision and accuracy of this assay is optimized, further research will be needed to add an appropriate normalizing gene to the assay.

Future Project Plans
Complete traditional dried stem plating for 2010 entries. Complete real-time PCR quantification of dried stem tissue for field and greenhouse studies. Run correlation analysis for stem sap, traditional dried stem plating results, and real-time PCR quantification. Screen seedling families and early generation selections for resistance to *Verticillium dahliae* following clone clean-up due to pathogen exposure.

Additional Information
Abstracts Pasche, JS, A Thompson, I Mallik, and NC Gudmestad. 2009. Evaluation of genetic resistance to *Verticillium dahliae* in potato using in vitro cultivation and quantitative PCR. 10th International Verticillium Symposium, Corfu, Greece.

Farnsworth, BL, NC Gudmestad, JA Pasche, GA Secor, N David, R Nilles, H Hatterman-Valenti, M Glynn, JR Sowokinos, C Rosen, D Preston, and AL Thompson. 2011. Dakota Trailblazer: a new, dual-purpose russet cultivar with *Verticillium* wilt resistance. Am J Potato Res 88:37-38.

Pasche, JS, AL Thompson, I Mallik, and NC Gudmestad. 2011. Evaluation of genetic resistance to *Verticillium dahliae* in potato using in vitro cultivation and quantitative PCR. Am J Potato Res 88:60-61.

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Inkster

Location:	Forest River Community, Inkster, ND
Dates:	
Planting:	May 22, 2009
Vine kill:	Vines flailed on October 6, 2009
Harvest:	October 7, 2009
Days to vine kill:	137 days
Days to harvest:	138 days
Plot information:	
Row width:	36 inches
Seed spacing:	12 inches
Hills per plot:	10
Replicates:	4
Method of planting:	2-row Harriston plot planter. Seed piece treatment (Tops MZ) was applied at cutting.
Method of harvest:	Machine - single row digger and hand pick up
Irrigation:	Linear
Fertilizer:	57#N, 200#K, 20#S; broadcast May 14, 2009 29#N, 100#P, 1#Zn; banded at planting 70#N; side dressed June 10 20#N; fertigation July 14 20#N; fertigation July 19 20#N; fertigation July 24
Herbicide applied:	Prowl (2.0 pt./a) + Matrix (1 oz./a) + Sencor (0.5 lb./a); June 12 Sencor (0.5 lb./a) + Matrix (1 oz./a); June 20
Fungicides applied:	June 8 — Bravo WS (1.5 pt./a) July 17 — Headline (6 oz/a) + Manzate (1.5 lbs./a) July 22 — Bravo Ultrex (1.3 lb./a) July 29 — Endura (2.5 oz./a) + Manzate (1.5 lbs./a) August 5 — Bravo Zn (2.125 pt./a) August 10 — Scala (7 oz./a) + Manzate (2 lb./a)
Insecticides applied:	Belay (12 oz/acre) applied in-furrow at planting.

Table 1. Agronomic and quality evaluations for advanced selections and cultivars, Inkster, 2009.

Clone	% Stand	Stems per Plant	Specific Gravity[1]	% Hollow Heart[2]	General Rating[3]
AND97279-5Russ	93	3.3	1.108	0	3.7
AOND95249-1Russ	96	2.5	1.115	0	3.9
AOND95292-3Russ	95	2.3	1.104	1	3.9
ETB 6-21-4	96	3.3	1.090	1	4.1
ND2858-1	98	2.6	1.114	0	3.0
ND6169-10Russ	96	2.5	1.076	1	4.0
ND6400C-1Russ	93	3.9	1.112	0	3.0
ND8068-5Russ	85	2.8	1.095	1	4.0
ND8229-3	93	4.6	1.092	0	4.0
ND039194-1Russ	96	2.3	1.097	0	3.9
ND049423b-1Russ	96	1.9	1.089	1	4.0
ND049506B-1Russ	98	2.0	1.092	0	3.6
ND049517B-1Russ	95	2.7	1.106	0	4.1
ND049546-10Russ	91	2.0	1.092	1	4.0
ND049589B-15Russ	96	2.1	1.082	1	3.4
ND059640B-3Russ	89	1.8	1.083	0	3.4
WND8624-2Russ	95	1.7	1.087	0	3.9
WND8625-2Russ	91	2.3	1.087	0	4.0
WND8625-3Russ	96	2.1	1.089	1	3.9
Bannock Russet	93	2.7	1.095	3	4.0
Ranger Russet	98	2.7	1.103	0	3.8
Russet Burbank	98	3.0	1.093	1	3.1
Russet Norkotah	94	2.7	1.080	10	4.3
Umatilla Russet	98	2.8	1.096	0	3.9
Mean	94	2.6	1.095	1	3.8
LSD (α=0.05)	6	1.5	0.009	2	0.2

[1] Determined using weight-in-air, weight-in-water method.
[2] Hollow heart includes brown center.
[3] General rating scale 1= very poor appearance and overall yield impression etc. 5 = excellent appearance and overall impression.

Table 2. Yield and grade for advanced selections and cultivars, full season, Inkster, 2009.

Clone	Total Yield Cwt./A	US No. 1 Cwt./A	US No. 1 %	0-4 oz. %	4-6 oz. %	6-12 oz. %	>12 oz. %	US No. 2's & Culls %
AND97279-5Russ	413	326	78	21	27	44	7	1
AOND95249-1Russ	499	457	91	7	14	53	25	1
AOND95292-3Russ	355	311	88	10	20	55	12	3
ETB 6-21-4	419	301	71	25	28	38	5	4
ND2858-1	170	59	34	59	30	4	0	7
ND6169-10Russ	461	424	92	6	15	47	30	3
ND6400C-1Russ	431	323	75	20	25	44	6	5
ND8068-5Russ	309	248	80	19	27	51	3	0
ND8229-3	448	409	91	7	17	50	24	3
ND039194-1Russ	517	475	92	5	6	37	49	4
ND049423b-1Russ	432	402	93	6	9	51	33	1
ND049506B-1Russ	509	478	94	5	13	56	25	1
ND049517B-1Russ	475	431	91	9	14	52	24	0
ND049546-10Russ	369	335	90	10	22	55	14	0
ND049589B-15Russ	440	404	92	8	14	52	25	1
ND059640B-3Russ	487	450	93	2	3	21	69	5
WND8624-2Russ	332	301	90	9	19	51	20	0
WND8625-2Russ	393	362	92	7	16	51	25	0
WND8625-3Russ	390	352	90	10	15	39	36	0
Bannock Russet	478	450	94	6	7	40	46	0
Ranger Russet	516	462	90	8	16	51	23	1
Russet Burbank	516	421	82	12	18	45	19	6
Russet Norkotah	465	424	91	9	11	51	29	0
Umatilla Russet	473	411	87	12	19	54	14	1
Mean	429	376	86	12	17	46	23	2
LSD (α=0.05)	56	57	5	5	5	8	9	4

Table 3. Quantification of *V. dahliae* cfu in fresh stem sap evaluated in mid-August, dried stem tissue collected prior to harvest, percentage *Verticillium* wilt symptoms expressed in the field, and vascular discoloration in cut tubers after grading, Inkster, 2009.

Clone	Stem Sap cfu[1]	Dried Stem Tissue cfu/gm[2]	Mean Wilt %[3]	Wilt Aug. 13 %	Wilt Aug. 20 %	Wilt Aug. 29 %	Wilt Sept. 12 %	Wilt Sept. 24 %	Vasc. Disc. %[4]
AND97279-5Russ	41	94	22	8	10	19	33	41	34
AOND95249-1Russ	33	4	4	0	0	1	4	16	20
AOND95292-3Russ	20	8	25	2	8	24	34	56	25
ETB 6-21-4	34	29	84	33	91	98	100	100	4
ND2858-1	32	14	13	2	3	7	13	39	1
ND6169-10Russ	39	56	66	18	45	78	91	100	8
ND6400C-1Russ	36	3	16	5	86	14	21	31	1
ND8068-5Russ	41	370	83	61	86	87	89	93	15
ND8229-3	28	11	6	0	1	3	7	18	15
ND039194-1Russ	35	26	13	2	3	6	18	38	11
ND049423b-1Russ	31	44	10	2	3	9	14	23	14
ND049506B-1Russ	30	24	15	0	4	10	20	43	14
ND049517B-1Russ	22	66	62	10	38	71	93	98	31
ND049546-10Russ	35	26	50	10	36	64	66	73	10
ND049589B-15Russ	36	193	51	13	33	56	73	82	23
ND059640B-3Russ	37	16	52	13	37	57	68	83	25
WND8624-2Russ	19	73	42	6	14	40	62	86	23
WND8625-2Russ	22	105	25	5	11	23	35	51	21
WND8625-3Russ	27	58	34	5	16	34	51	62	18
Bannock Russet	20	5	25	9	14	27	31	42	16
Ranger Russet	32	3	26	5	10	23	42	50	20
Russet Burbank	27	28	18	4	6	12	24	43	26
Russet Norkotah	28	1693	76	34	66	83	98	99	19
Umatilla Russet	35	34	39	5	9	36	59	87	3
Mean	31	124	36	11	23	37	48	60	16
LSD ($\alpha = 0.05$)	13	747	18	11	17	22	25	30	12

[1] Sap extracted from four single stems per plot was used to determine mean cfus for 10 ul sap.
[2] Five stems per plot were dried, ground and two subsamples plated. A mean of the two subsamples is reported per gram of dried tissue.
[3] Mean percentage *Verticillium* wilt symptoms determined by adding plot percentage for each evaluation date and dividing by total plots rated.
[4] Ten random tubers ranging in size from 6 to 12 ounces were cut for internal evaluation. Each tuber expressing vascular discoloration was counted, a percentage of tubers with discoloration determined.

Insecticides applied: Admire Pro (8.7 oz/acre) + Ultra Flourish (12.2 oz/acre) applied in-furrow at planting
Kasio (2 oz/acre); August 6

Table 4. Agronomic and quality evaluations for advanced selections and cultivars, Inkster, 2010.

Clone	% Stand	Stems per Plant	Specific Gravity[1]	% Hollow Heart[2]	General Rating[3]
AND97279-5Russ	94	3.6	1.1026	0	3.9
Dakota Trailblazer*	91	3.0	1.0995	1	4.1
AOND95292-3Russ	91	3.0	1.0948	2	4.0
ETB 5-31-5	80	3.0	1.0765	3	3.1
ND2858-1	85	2.4	-	-	3.0
ND6169-10Russ	85	3.3	1.0675	0	3.4
ND6400C-1Russ	86	3.5	1.1037	3	3.0
ND8068-5Russ	91	3.5	1.0872	1	3.9
ND8229-3	85	2.7	1.0871	0	4.1
ND049423b-1Russ	91	2.5	1.0866	2	3.9
ND049517B-1Russ	90	3.0	1.0923	0	4.0
ND049546-10Russ	81	1.9	1.0839	1	3.9
ND049589B-15Russ	89	2.6	1.0802	0	4.0
WND8624-2Russ	84	2.9	1.0845	0	4.0
WND8625-2Russ	76	3.1	1.0797	1	4.0
WND8625-3Russ	86	2.4	1.0721	2	3.7
Bannock Russet	84	3.4	1.0878	3	3.9
Ranger Russet	88	3.6	1.0972	0	3.6
Russet Burbank	88	3.7	1.0839	2	3.1
Russet Norkotah	91	3.4	1.0785	0	4.1
Umatilla Russet	89	3.6	1.0885	1	3.6
Native soil levels	87	3.0	1.0863	1	3.7
Inoculated soil	87	3.1	1.0871	1	3.7
Mean	87	3.1	1.0867	1	3.7
LSD ($\propto$=0.05)	6	0.3	0.0058	1	0.1

*Tested as AOND95249-1Russ

[1] Determined using weight-in-air, weight-in-water method.

[2] Hollow heart includes brown center.

[3] General rating scale 1= very poor appearance and overall yield impression etc. 5 = excellent appearance and overall impression.

Table 5. Yield and grade for advanced selections and cultivars, full season, Inkster, 2010.

Clone	Total Yield Cwt./A	US No. 1 Cwt./A	US No. 1 %	0-4 oz. %	4-6 oz. %	6-12 oz. %	>12 oz. %	US No. 2's & Culls %
AND97279-5Russ	441	359	80	19	22	40	18	1
Dakota Trailblazer	601	557	93	6	13	50	29	1
AOND95292-3Russ	372	329	88	11	22	54	12	1
ETB 5-31-5	312	237	75	13	14	39	22	12
ND2858-1	5	0	0	100	0	0	0	0
ND6169-10Russ	462	382	83	14	15	38	30	4
ND6400C-1Russ	419	286	68	31	26	33	9	1
ND8068-5Russ	382	311	80	19	23	47	10	0
ND8229-3	429	395	92	7	14	51	27	1
ND049423b-1Russ	463	418	90	7	11	41	38	2
ND049517B-1Russ	518	489	94	5	9	41	44	1
ND049546-10Russ	249	229	89	11	17	59	14	0
ND049589B-15Russ	440	396	90	10	13	45	32	0
WND8624-2Russ	302	267	88	11	22	48	18	1
WND8625-2Russ	285	254	88	11	16	43	29	1
WND8625-3Russ	333	274	82	15	17	40	25	3
Bannock Russet	479	445	93	6	10	45	37	1
Ranger Russet	531	455	85	9	19	43	24	5
Russet Burbank	410	306	74	18	17	39	18	8
Russet Norkotah	484	421	87	12	16	46	25	1
Umatilla Russet	515	432	83	15	22	48	14	1
Native soil levels	404	347	81	17	16	42	23	2
Inoculated soil	399	343	81	17	16	43	22	2
Mean	402	345	82	16	16	43	23	2
LSD (α=0.05)	52	52	4	3	4	4	7	2

Table 6. Quantification of *V. dahliae* cfu in fresh stem sap evaluated in mid-August, percentage Verticillium wilt symptoms expressed in the field, and vascular discoloration in cut tubers after grading, Inkster, 2010.

Clone	Stem Sap cfu[1]	Mean Wilt %[2]	Wilt Aug. 9 %	Wilt Aug. 17 %	Wilt Aug. 26 %	Wilt Sept. 5 %	Wilt Sept. 12 %	Wilt Sept. 20 %	Vasc. Disc. %[3]
AND97279-5Russ	0	20	25	24	26	16	8	19	6
Dakota Trailblazer	5	14	3	6	9	26	19	23	1
AOND95292-3Russ	3	10	11	9	10	11	9	8	10
ETB 5-31-5	6	24	25	23	25	25	23	23	17
ND2858-1	0	1	0	0	0	3	1	4	-
ND6169-10Russ	3	20	24	24	20	20	18	16	3
ND6400C-1Russ	1	25	23	25	28	25	25	29	4
ND8068-5Russ	8	48	41	40	63	56	54	35	14
ND8229-3	3	18	17	19	20	16	19	18	5
ND049423b-1Russ	3	28	19	26	34	30	29	30	8
ND049517B-1Russ	5	44	31	36	41	55	55	48	29
ND049546-10Russ	2	26	39	28	26	21	21	20	3
ND049589B-15Russ	0	33	26	33	35	34	34	38	10
WND8624-2Russ	6	40	35	33	39	44	45	43	6
WND8625-2Russ	3	55	49	50	51	59	61	60	6
WND8625-3Russ	1	40	34	41	41	36	41	44	18
Bannock Russet	1	15	13	13	15	19	16	16	3
Ranger Russet	0	17	28	20	21	11	10	10	9
Russet Burbank	3	17	14	15	15	13	24	24	8
Russet Norkotah	46	56	34	43	56	69	71	65	13
Umatilla Russet	0	29	15	23	33	34	36	36	5
Native soil levels	5	28	22	24	28	32	31	30	9
Inoculated soil	4	28	26	26	30	27	28	28	8
Mean	5	28	24	25	29	30	29	29	9
LSD ($\alpha = 0.05$)	14	9	9	9	10	13	12	12	6

[1] Sap extracted from four single stems per plot was used to determine mean cfus for 10 ul sap.
[2] Mean percentage *Verticillium* wilt symptoms determined by adding plot percentage for each evaluation date and dividing by total plots rated.
[3] Ten random tubers ranging in size from 6 to 12 ounces were cut for internal evaluation. Each tuber expressing vascular discoloration was counted; a percentage of tubers with discoloration determined.

Table 7. Presence of CAPS marker bands in NDSU potato breeding genotypes used in determining potential resistance to *Verticillium dahliae*.

Entry#	Genotype	1154 bp band	1204 bp band	Type
1	AND97279-5Russ	Y	Y	R
2	Dakota Trailblazer	Y	Y	R
3	AOND95292-3Russ	Y	Y	R
4	ETB 5-31-5	Y	N	S
5	ND2858-1	N	Y	U
6	ND6169-10Russ	Y	Y	R
7	ND6400C-1Russ	N	Y	U
8	ND8068-5Russ	Y	Y	R
9	ND8229-3	Y	Y	R
10	ND049423b-1Russ	N	Y	U
11	ND049517B-1Russ	-	-	U
12	ND049546-10Russ	Y	Y	R
13	ND049589B-15Russ	Y	Y	R
14	WND8624-2Russ	Y	N	S
15	WND8625-2Russ	Y	N	S
16	WND8625-3Russ	Y	N	S
17	Bannock Russet	Y	Y	R
18	Ranger Russet	Y	Y	R
19	Russet Burbank	Y	Y	R
20	Russet Norkotah	Y	Y	R
21	Umatilla Russet	Y	Y	R

Literature Cited

Atallah, Z.K., Bae, J., Jansky, S.H., Rouse, D.I. and Stevenson, W.R. 2007. Multiplex real-time quantitative PCR to detect and quantify *Verticillium dahliae* colonization in potato lines that differ in response to Verticillium wilt. Phytopathology 97:865-872.

Atallah, Z. K. and Stevenson, W. R. 2006. A methodology to detect and quantify five pathogens causing potato tuber decay using real-time quantitative polymerase chain reaction. Phytopathology 96:1037-1045.

Bae, J.J., Halterman, D. and Jansky. S.H. 2008. Development of a molecular marker associated with Verticillium wilt resistance in diploid interspecific potato hybrids. Mol. Breeding 22:61-69.

Jansky, S.H. 2009. Identification of Verticillium wilt resistance in U.S. potato breeding programs. Am J Potato Res 86(6):504-512.

PROJECT TITLE

Evaluation of Hardy Roses for Cut Flower Production

PROJECT SUMMARY

Rose is the most popular cut flower in North Dakota but almost no roses are commercially grown in the state. The lack of hardiness among roses severely limits their production.

Major advances in rose breeding have led to the development of numerous hardy varieties in recent years. The Morden Research Station in Manitoba and Bailey Nurseries in Minnesota led these efforts. Many of these hardy varieties are reported to be well suited for cut flower production. Although these varieties show great promise, very few growers are aware of them.

A survey coordinated by the North Dakota Department of Agriculture in 2008 identified a desire by consumers for more cut flowers and other products to be sold at local markets. There is additional demand for locally grown roses from restaurants, business establishments, and hotels.

This project evaluated the qualities of 137 varieties of roses for commercial production and landscaping. Approximately 760 gardeners learned of rose varieties and production through a series of 10 workshops conducted across the state in 2010. Approximately 280 gardeners were educated through 5 workshops and tours conducted in 2011. Videos on rose varieties and production were published online. The planting is on display and open to the public.

PROJECT APPROACH

Evaluation. A total of 137 rose varieties were evaluated for hardiness, bloom color and form, fragrance, floral impact, vigor, disease resistance, and repeat bloom. Varieties included:

Buck (66 varieties): American Legacy, Amiga Mia, Applejack, April Moon, Aunt Honey, Barn Dance, Blue Skies, Bright Melody, Butterfly Magic, Calico Gal, Chorale, Chuckles, Cinnamon Spice, Country Dancer, Country Music, Countryman, Dawn Star, Distant Drums, Dorcas, Earth Song, El Catala, Enchanted Autumn, Folksinger, Freckles, Gentle Persuasion, Golden Princess, Golden Unicorn, Grandpa's Boy, Griff s Red, Habanera, Hawkeye Belle, Hi Neighbor, Honey Sweet, Incredible, Iowa Belle, Kathy's Find, Malaguena, Mary Susan, Mavourneen, Mountain Music, Music Maker, Pearlie Mae, Piccolo Pete, Polonaise, Prairie Breeze, Prairie Clogger, Prairie Harvest, Prairie Princess, Prairie Squire, Prairie Star, Prairie Sunrise, Princess Verona, Quietness, Red Dream, Rural Rhythm, Serendipity, Silver Shadows, Simon Estes, Square Dancer, Summer Honey, Summer Wind, Virginia Reel, Queen Bee, Wanderin' Wind, Wild Ginger, Winter Sunset.

Bailey's Easy Elegance (13): All the Rage, High Voltage, Kashmir, Little Mischief, My Girl, Mystic Fairy, Paint the Town, Pinktopia, Snowdrift, Sunrise Sunset, Super Hero, Yellow Brick Road, Yellow Submarine.

Austin (10): Charlotte, Crocus Rose, Eglantyne, Gertrude Jekyll, Golden Celebration, Graham Thomas, L.D. Braithwaite, Mary Rose, St. Swithun, Winchester Cathedral.

Parkland (10): Adelaide Hoodless, Hope for Humanity, Morden Blush, Morden Centennial, Morden Fireglow, Morden Ruby, Morden Snowbeauty, Morden Sunrise, Prairie Joy, Winnipeg Parks.

Explorer (9): Alexander MacKenzie, Champlain, Charles Albanel, Cuthbert Grant, David Thompson, George Vancouver, J.P. Connell, John Franklin, Lambert Closse.

Carefree (7): Carefree Beauty, Carefree Celebration, Carefree Delight, Carefree Marvel, Carefree Spirit, Carefree Sunshine, Carefree Wonder.

Knock Out (7): Blushing Knock Out, Double Knock Out, Double Pink Knock Out, Knock Out, Pink Knock Out, Rainbow Knock Out, Sunny Knock Out.

Other (5): Chuckles, Easy Does It, Ebb Tide, Nearly Wild, Seafoam.

Heirloom (4): Gruss An Aachen, LaMarne, Stanwell Perpetual, Topaz Jewel.

Iceberg (3): Iceberg, Brilliant Pink Iceberg, Burgundy Iceberg.

Meideland (2): White Meideland, Scarlet Meideland.

Minnesota Northern Accents: (2): Ole, Sven.

Education. Approximately 760 gardeners and commercial growers learned how to grow roses and other flowers in a series of ten presentations conducted in Beulah, Bismarck (four presentations), Bowman, Fessenden, Grand Forks, Hettinger, Steele, and Williston. Topics included "Growing Roses for Beginners," "Growing Roses for Advanced Growers," and "Growing Fragrant Roses in the North." These talks covered soil preparation, variety selection, irrigation, pest management, and harvesting. Furthermore, Parkland and rugosa roses were featured in presentations on tough landscape plants and recommended flowers for North Dakota. Growers appreciated the quality of information provided as they rated the programs with an average score of 4.74 (on a scale of 1 to 5 with 1 = not useful and 5 = very useful). In 2011, five workshops and tours were conducted and online videos on rose varieties and production were published.

GOALS AND OUTCOMES ACHIEVED

This project evaluated 137 rose varieties for hardiness, bloom color and form, fragrance, floral impact, vigor, disease resistance, and repeat bloom.

Two videos, one on rose varieties and one on rose production, were developed and used as training materials to empower growers to prove locally grown roses. Summaries of Power Point presentations were also developed for training and distributed to workshop participants.

Approximately 760 gardeners learned of rose varieties and production through a series of training presentations at ten workshops conducted across the state in 2010. They learned how to grow roses and other flowers through the workshops in Beulah, Bismarck (four presentations), Bowman, Fessenden, Grand Forks, Hettinger, Steele, and Williston. Approximately 280 gardeners were educated through the presentations at five workshops and tours conducted in 2011. Videos on rose varieties and production were published online and have been downloaded by approximately 100 people.

The permanent rose beds were established at UTTC. These beds are open to the public and are used for tours, workshops, and educational programs conducted through mass media.

BENEFICIARIES

Approximately 760 persons learned how to grow roses and other flowers in a series of presentations conducted in 2010. Hundreds more learned through workshops, tours, and online videos in 2011.

Students of UTTC now have an outdoor laboratory to learn basics of commercial flower production.

The general public now has a botanic garden where they can observe hundreds of varieties of roses and other flowers. Over 1,000 gardeners are expected annually.

Plantings from this rose project generated interest in establishing adjacent gardens that demonstrate superior production practices of vegetables and fruits. These are being established using other funding.

The establishment of this garden is supporting a new initiative to teach horticulture via cable television and the internet, thereby reaching thousands of new gardeners with research-based information. Thousands of viewers in northern climates across the nation will benefit from this initiative.

LESSONS LEARNED

The public has a strong demand for horticulture information; the classes on growing roses were attended by record-breaking crowds throughout the state. Hardiness and resistance to disease were key factors in selecting the most appropriate varieties for our region.

CONTACT PERSON

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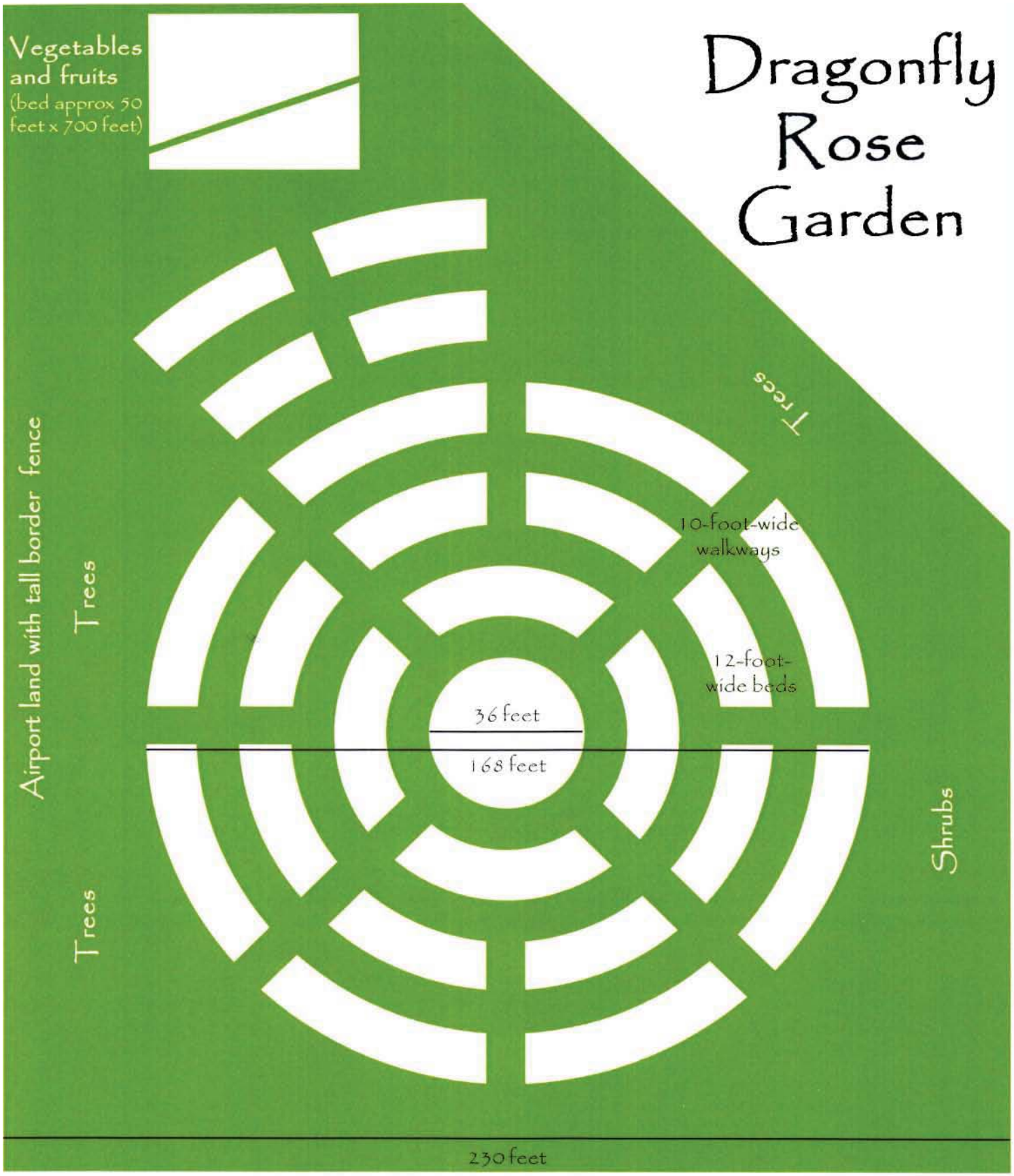
ADDITIONAL INFORMATION

Attached are:

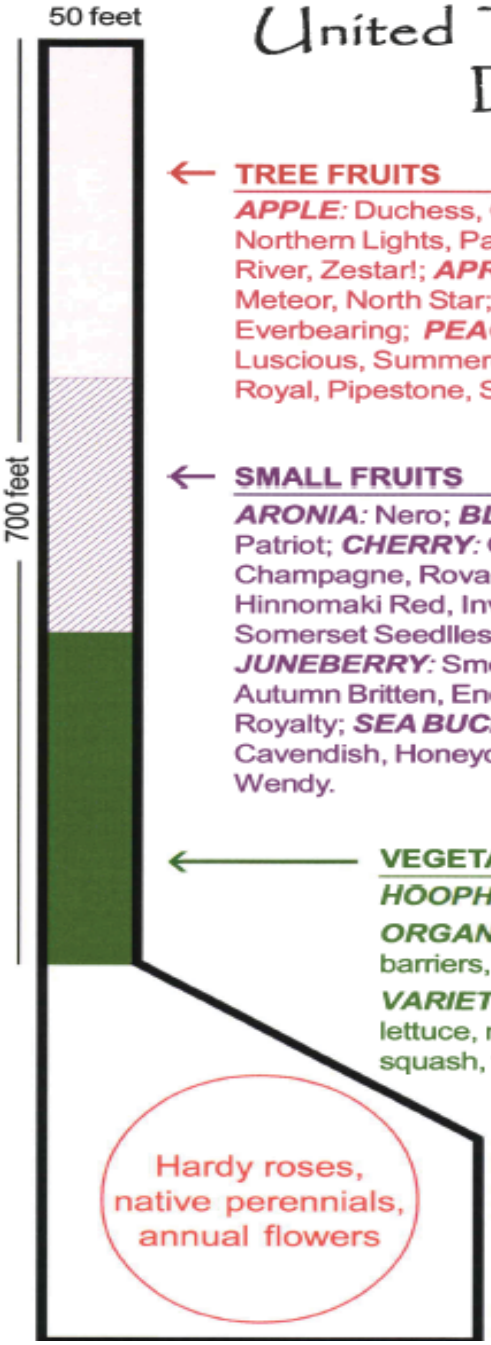
- Design of the rose planting, using a medicine wheel design.
- Proposed overall garden, including vegetable/fruit plantings. The presence of the rose plantings is helping us to generate support for these vegetable/fruit plantings using outside funds.
- A photo of the site.



Gravel for parking

↑South

United Tribes Technical College Dragonfly Garden



TREE FRUITS

APPLE: Duchess, Goodland, Haralred, Hazen, Honeycrisp, Lodi, Northern Lights, Paulared, Prairie Magic, Red Baron, SnowSweet, Wolf River, Zestar!; ***APRICOT:*** Chinese, Scout, Westcot; ***CHERRY:*** Evans, Meteor, North Star; ***CRABAPPLE:*** Chestnut, Dolgo; ***MULBERRY:*** Illinois Everbearing; ***PEACH:*** Contender, Reliance; ***PEAR:*** Golden Spice, Luscious, Summercrisp, Ure; ***PLUM:*** Alderman, LaCrescent, Mount Royal, Pipestone, Superior, Toka, Underwood, Waneta.

SMALL FRUITS

ARONIA: Nero; ***BLACKBERRY:*** Prime Jan, Prime Jim; ***BLUEBERRY:*** Patriot; ***CHERRY:*** Carmine Jewel; ***CURRANT:*** Ben Sarek, Pink Champagne, Rovada; ***ELDERBERRY:*** Samdal, Samyl; ***GOOSEBERRY:*** Hinnomaki Red, Invicta, Tixia; ***GRAPE:*** King of the North, Marquette, Somerset Seedlless, Valiant; ***HASKAP:*** Berry Belle, Borealis, Tundra; ***JUNEBERRY:*** Smoky; ***KIWI:*** Arctic Beauty, Pasha; ***RASPBERRY:*** Anne, Autumn Britten, Encore, Killarney, Latham, Nova, Prelude, Polana, Royalty; ***SEA BUCKTHORN:*** Leikora, Male; ***STRAWBERRY:*** Cabot, Cavendish, Honeyoye, Mara Des Bois, Mesabi, Ozark Beauty, Sparkle, Wendy.

VEGETABLES

HOOPHOUSES: High tunnel and low tunnel.

ORGANIC PEST MANAGEMENT: Natural pesticides, pest barriers, disease-resistant varieties.

VARIETY TRIALS: Over 100 varieties including bean, corn, lettuce, melon, pea, pepper, potato, pumpkin, radish, spinach, squash, tomato.

USDA Specialty Crop Grant - final report

NDFMGA Specialty Crop Grant 2009 Project #8 - Expanding North Dakota Farmers Markets

• Project Summary

1) Although the NDFMGA has done a fabulous job of providing support for and increasing the number of farmers markets in North Dakota, very little tangible information about the markets themselves is available. This information is necessary for the Association to provide relevant educational and promotional activities as well as apply for grants and programs that will support the markets and production of local produce into the future.

2) The number of farmers markets in North Dakota continues to rise each year. Although markets received funding through the Specialty Crops program in the 2008 granting period (2009 season), new markets have been initiated as the demand for local fruits and vegetables continues to rise. The North Dakota Famers Markets and Growers Association foresees additional markets beginning in the 2010 season with a need for marketing funding to help inform customers of their existence. Additionally, most markets in North Dakota do not have paid or full time managers to market and promote them. These funds will help to ensure marketing and promotion efforts are carried out.

3) The North Dakota Department of Agriculture has been providing education and promotion to schools to increase the number of schools involved with the preparation and serving of locally grown fruits and vegetables in school lunch programs. Many North Dakota schools are very rural and have land available for school gardens. In the 2008 granting period all 'Green and Growing' school garden grants were claimed by schools who had not been previously funded through this initiative. There are 567 public schools K-12 in North Dakota. Only fourteen schools have received funding to date to begin school gardens. Of these fourteen, all have reported success with more vegetables being consumed by school age children and students involved in the growing and preparation of vegetables in the school lunch program. In the initial round funded by the ND Department of Agriculture, 30 applications were received for four grants. In the 2009 granting cycle through the Specialty Crops program, 40 applications were received with 10 receiving funding. It is evident that more schools are interested and willing to participate in the program should the funding become available. This increase in student activity in the growing of fruits and vegetables will not only increase consumption but hopefully spur entrepreneurial spirit in young people who may wish to participate in growing and sales of fruits and vegetables outside of school at local farmers markets.

To ensure that all funds were used to solely enhance the competitiveness of specialty crops, all sub-grants were monitored by the NDFMGA and ECH staff. Grant guidelines for the Mini Grants and Green and Growing grants clearly indicated they were for the purchase of materials, marketing of and growing of only specialty crops. Mini grant and Green and Growing grant recipients were chosen based on their projected use of funds

and that use needed to be for specialty crops only. Each grant recipient submitted examples of marketing and final reports indicating how the funds were used and NDFMGA/ECH staff reviewed each report to ensure proper use of the funds.

In the case of the Exploration sub-grants, each recipient had to enter into a separate and specific contract with the NDFMGA. This contract outlined the specific information the market would collect. Information to be collected was chosen by the NDFMGA and regarded only specialty crops.

- **Project Approach**

To approach the problem, the NDFMGA initiated the following:

1) Provided 'Market Exploration' grants to 21 farmers markets in North Dakota. In exchange for the grant funds, the markets provided the NDFMGA with valuable information to better serve the needs of their member markets through education and promotional efforts thus helping the fruit and vegetable growers increase their incomes.

2) Provided a mini-grant marketing program to 36 locally organized farmers markets solely for the purpose of increasing awareness of the availability of local fruits and vegetables at those farmers markets.

3) Provided 'Green and Growing' grants to 10 schools in North Dakota who had not been previously funded to begin a school garden or locally sourced produce program. These grants created an opportunity for students in North Dakota schools to learn about the production and marketing of vegetables. The NDFMGA was very encouraged to see that each school took on a variety of community partners to accomplish their goals including local farmers markets, FFA Alumni, Extension Service personnel, local garden center and nursery retailers, local nursing home staff and residents, and local residents. These partners made significant investments in time, labor, and donations to make the Green and Growing programs successful.

- **Goals and Outcomes Achieved**

To achieve the goals for the project, the NDFMGA followed the procedures outlined below for each phase of the endeavor:

1) The 'Market Exploration' grant program was advertised to all North Dakota farmers markets via the newsletter, mass mailings and press releases. Funds were available to assist up to 36 markets with $500 grants. Grant applications also stated that any funds remaining in the event that there were not sufficient applications to spend the entire amount allocated for this program, would be pro-rated to the successful applicants over and above the $500 grant. Application deadline was May 10th, 2010 and funds were dispersed in June. Each applicant market entered into a customized contract with the NDFMGA based on their ability and market needs. These contracts outlined the type and amount of information the market

would gather and report to the NDFMGA from the market season. An intern was hired by the NDFMGA to assist in collecting information and guiding markets with data collection. All data collected was combined into a single report to be dispersed to the North Dakota Department of Agriculture, the NDFMGA, its Board and members.

2) The mini-grant program was advertised to all North Dakota farmers markets via the NDFMGA newsletter, mass mailings and press releases. The $10,000 in specialty crop grant funds for the mini-grant program were supplemented with $8,000 from the North Dakota Department of Agriculture to bring the total available for the program to $18,000. This amount was enough to fund 36 markets at $500. Grant applications also stated that any funds remaining in the event that there were not sufficient applications to spend the entire amount allocated for this program, would be pro-rated to the successful applicants over and above the $500 grant. Applications were due May 10, 2010 and funds were dispersed by the NDFMGA in June. Each market approved for the grant was required to submit receipts for marketing and promotional items purchased with grant funds as well as examples of marketing materials. All receipts and examples were gathered and compiled by the Executive Director and assistant of the NDFMGA.

3) Each school in North Dakota was contacted via letter in regards to the 'Green and Growing' grant program opportunity. The list of schools was obtained from the North Dakota Department of Instruction. Grant applicants were asked to identify: the project coordinator, the goals of the project, additional school resources that would be used to fulfill the project goals, teachers and faculty that would be involved in the program, school financial resources used for the project, support from school administration, community resources that would used and a budget for the project. Grants were reviewed and approved on a first-come first-serve basis. Funds in this portion of the Specialty Crop grant ($5,000) were capable of serving 10 schools with $500 grants. Fourteen applications were received and additional funding from the North Dakota Department of Agriculture was obtained to approve all 14 grant requests. Grantees were required to report by November 15th, 2010 on the results of their project. The reports were to include: learner environment and activities, learner outcomes, partners, resources used, funding sources, project evaluation and plan for sustaining the activities as a result of this program. All reports were gathered and compiled by the Executive Director and assistant of the NDFMGA.

- **How progress has been made to achieve long term outcome measures for each project.**

The NDFMGA has applied for and received a USDA Farmers Market Promotion Program grant. The funds will be used for a statewide marketing campaign that will increase consumer awareness about the local farmers markets and the Association across the state. This increased awareness will help to build the branding of the Association and the membership in the Association which is based on the number of vendors at each market. Increased funding from membership dues will allow the Association to increase its services and build granting programs for its members. In addition, the Association has applied for and received a charitable solicitation registration with the state of North Dakota. This registration will allow the Association to solicit donors and sponsors for its programs and services. The NDFMGA Board of Directors strategic plan includes a strategy for contacting and garnering support from North Dakota businesses and organizations. These actions will allow the Association funding necessary to continue grant

programs and educational opportunities into the future. The Market Exploration grant program long term outcome was to build a base of information that will be used by the NDFMGA as it applies for future grants and funding and to use the base of information to guide markets and producers in areas for growth and opportunities for expansion.

- **Actual Accomplishments based on Goals for the Project and Completion of Outcomes.**

1) Market Exploration Grants - Twenty-one 'Market Exploration' grants were awarded to farmers markets in North Dakota. Thirteen markets submitted price and product information. From these lists it is clear that pricing varies widely across the state and the method of 'what the market will bear' is a good pricing strategy for producers in North Dakota. Gross sales figures by product and date were submitted by five markets from a variety of areas within the state. These figures will set the stage for the Association to build economic data models for producers in North Dakota. Vendor numbers by date were also submitted by nine markets that will allow the NDFMGA to determine when the markets are most active, when early and late season pricing will benefit producers and when educating consumers regarding local produce will be most effective.

2) Mini Grant Program – Thirty-six mini-grants were awarded to locally organized farmers markets for the purpose of increasing awareness and availability of local fruits and vegetables at those farmers markets. The markets used a variety of methods for marketing. Markets submitted receipts and examples of marketing and promotional materials as validation the funds were spent in a manner compliant with the grant. Six markets who had not previously received funds or were new markets utilized the funds to increase the awareness of local fruit and vegetable availability in their communities. This 17% increase in markets and production/availability of local fruits and vegetables is an indicator of the success of this program.

3) Green and Growing grants - Fourteen 'Green and Growing' grants were awarded to schools in North Dakota who had not been previously funded to begin a school garden or locally sourced produce program. Ten were funded through the Specialty Crops program and four through the generosity of the North Dakota Department of Agriculture. Although approached differently, each school created a garden or production area that will incorporate fruits and vegetables into the activities of the students. Several schools chose to plant fruit trees with their grant funds. This method of introducing children to gardens and edible products works well for the schools in North Dakota as the blooming time and harvest time better correspond to the school year. Almost all school incorporated the products from the gardens either into their lunch or snack programs for the students. Some schools sold extra product at local farmers markets, thereby giving students a chance to learn about marketing and sales while some donated extra produce to local food banks incorporating a service learning theme to their gardens. All schools identified and implemented curriculum into classrooms to broaden the experience for students. Each school identified ways in which they will keep the gardens going in future years. These plans included using revenue from farmers market sales to fund future seed and maintenance needs, incorporating the school garden with local community garden plots funded through the city, use of parent fees for sustainment, and incorporation of the school garden into FFA and other school organization activities. Learner outcomes are too numerous to mention although a few of the most important were the students opportunity to be part of their schools and communities through farmers markets, food bank donations, relationships built with the elderly through cooperative work in the gardens and the pride students took in using what they had grown in their school garden in school lunch and snack programs.

- **Beneficiaries**

This project's accomplishments and beneficiaries are many. Each of the 21 Exploration Grant markets, 36 Mini Grant markets and fourteen schools receiving Green and Growing grants benefitted from this project. Through trickle down, each of the over 250 vendors at the participating markets and children in all of the schools will also benefit from the project. One Green and Growing school grant recipient mentioned specifically the benefits the local nursing home received as a part of the project, building community and relationships between the students and the nursing home clients. Schools worked with local retail businesses, nursing homes, local organizations, local food bank personnel and others within their communities to continue the trickledown effect of this grant.

Additionally, the NDFMGA benefitted from the project by gaining valuable information regarding market economics in North Dakota. This information was used to apply for and receive a Federal Farmers Market Promotion Program grant that will be used in 2011 to promote consumption and sale of locally grown produce and a branding campaign.

Quantitatively, information gained regarding product pricing, gross sales by market vendors, and market total gross sales will form the base for economic modeling of the impact of farmers markets on their communities. This information will be used to validate the importance of a farmers market in communities, garner community and private sector support for markets and integrate markets as institutions within communities.

- **Lessons Learned**

The Specialty Crop grant program was a very successful one for the NDFMGA. Using the funds to grant markets and schools money for the production and sale of locally produced fruits and vegetables has helped establish a future market for producers across the state. Especially helpful was the 'Market Exploration' grants program which has provided the NDFMGA, state and local economic development entities, and communities with economic impact data and producer networks on which to base future programs. This information will be invaluable as the local foods movements work toward a sustainable future in the North Dakota. Lessons learned from each of the three granting programs carried out by the NDFMGA through the Specialty Crops grant are outlined below.

1)Market Exploration Grants - The information gathered from the markets was not only extremely valuable; it was very eye opening as well. Should this program be offered again in the future, it would be wise to require pricing information from grant recipients so a more in-depth look at pricing statewide can be gathered. Markets also submitted contact information for producers. This will allow the Association better access to producers to offer educational and networking opportunities and build a coordinated system of delivery for information regarding workshops, conferences, and the exchange of ideas. Overall, the Market Exploration grant program will be the most valuable to the producers and communities within North Dakota and the NDFMGA.

2) Mini Grant Program - Among the most creative and effective methods were markets that provided coupons to the local food pantry for the people served through the food pantry service. This allowed low income or needy individuals' access to fresh fruits and vegetables. Several markets used the funds to promote National Farmers Market week events, market picnics, harvest feasts and local foods festivals that featured chefs, demonstrations, recipes and ideas on preparing and preserving vegetables and fruits at home.

Informal survey of market managers indicates the mini-grant program is an integral part of the marketing funds for these farmers markets. Many North Dakota markets, while organized with boards and by-laws, are managed by volunteer staff with little or no experience. Many of the volunteer managers are also vendors at the market. By nature then, all marketing, promotion and event planning is completed by a person who is not paid but willingly gives any extra moment to these duties; but time is always in short supply. Market managers in North Dakota struggle to spend time on appropriate marketing and the necessary fund raising to keep a market financially viable. Some markets operate with fewer than six vendors. With small vendor numbers, stall fees – unless unreasonably high – will never cover the marketing it takes to inform the geographically widespread consumers in rural areas of the availability of produce, market days, times and events. The lesson learned with this portion of the project is that the North Dakota Farmers Market and Growers Association should pursue a way to continue the mini-grant program until the markets have enough vendors and supporters to be self-sustaining or risk a decline in the number of markets.

3) Green and Growing grants – Although the NDFMGA was very careful in wording its application for grantees and screened each applicant thoroughly to ensure goals would be met, it was clear once the final reports became available that more emphasis must be placed on fruits and vegetables as that will be donated or used within the school system. This is a tough spot for many schools in North Dakota who do not have students or staff available during the majority of the harvest season and/or do not have the ability to preserve summer's harvest for fall/winter school sessions. The idea of planting fruit trees, most of which ripen in the fall at times when school is in session, is a good one and should be pursued further. The NDFMGA has followed up with the school regarding another grant opportunity that focuses on the planting of orchards.

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

The North Dakota Farmers Market and Growers Association website: www.ndfarmersmarkets.com

- Past quarterly NDFMGA newsletters available upon request.
- Copies of the final 'Market Exploration Grant' report are available upon request with a small mailing and copying charge.
- Copies of 'Green and Growing Grant' final reports from schools available upon request for a small mailing and copying charge.
- Copies of the 'Market Mini-grant' program market receipts available to the North Dakota Department of Agriculture and the USDA upon request.

Contact person

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Specialty Crop Grant Final Report

PROJECT TITLE

North Dakota Grape Growers Creation of Wine Grape Hybrids for ND

PROJECT SUMMARY

Grape growers in North Dakota have been plagued with winter hardiness issues even with the cold hardy cultivars from the University of Minnesota. Inconsistent survival of the above ground portions of a grape vine have resulted in years with little to no fruit production. Vines dieback close to the ground or just below the snowline, resulting in dead fruitful buds along the vine cordons. These conditions have occurred throughout the state, but are more prevalent in the western part of the state due to inconsistent snow cover. Vine dieback has led to the identification of three objectives by the North Dakota Grape Growers Association. These objectives are: 1) Development of one red and one white wine grape hybrid with hardiness to -40 degree F and *Vitis vinifera* flavor characteristics, 2) conduct microvinification trials by 2015, and 3) select grape hybrids for overall hardiness followed by short maturity period, wine quality, grape cluster size, and finally by disease resistance.

Seedlings from crosses made using cold hardy *Vitis riparia* as a parent must be exposed to selective conditions of North Dakota. The NDSU grape breeding project has been initiated to reach the goals set forth by the North Dakota Grape and Wine Program Committee: to develop at least one red winegrape and one white winegrape with hardiness to at least -40, fruit ripening at 1800 GGDs (base 50◦F), moderate tannin structure, consistent year to year yields, 5 oz. cluster size, and juice pH of at least 3.2 (red 22 brix and white 20 brix). To accomplish this goal, the project is utilizing an accelerated greenhouse approach as identified by Tyler Kaban, University of Saskatchewan, as well as traditional grape breeding procedures. In addition, this project will provide a coordinated approach to the evaluation, and dissemination of knowledge gained by cooperator evaluation of existing and newly released winegrape varieties at the Research Extension Centers.

PROJECT APPROACH

Controlled Crosses

Currently, many types of crosses including inter-specific hybrid x inter-specific hybrid, *V. riparia* x *V. vinifera*, and selfing of selections have been utilized in the NDSU grape breeding program. The inter-specific x inter-specific crosses are for short-term program goals. These are crosses between elite cultivars and/or proven parent vines of other northern grape breeding programs. In general, these crosses involve parent types that are hardy and fill each others weaknesses in cultural or quality traits. Crosses which use vines of similar backgrounds as those used in successful crosses conducted by other breeding programs are also being investigated. This coupled with the increased selection pressures of North Dakota will allow for vines better able to survive in this region consistently. This will aid in increased stability for the producers of the region, allowing for small vineyards to grow.

In 2010 and 2011, fifty-three and twenty-two individual vines were crossed, respectively.

The most notable of the short-term crosses conducted include the following:

Frontenac Gris x Alpenglow
- Frontenac x Petite Pearl
- MN 1094 X Frontenac
- MN 1131 X MN 1094
- MN 1094 X ES 12-06-18

Looking toward the long-term goal of producing parent vines from which adapted progeny could be derived, *V. vinifera* x *V. riparia* crosses have also been pursued. *V. vinifera* is the traditional wine grape grown in Europe and California and *V. riparia* is the riverbank grape native to North Dakota. To accomplish this, crosses have been made between many native grapevines collected from within this region or hardy inter-specific hybrids with *V. vinifera* cultivars with early producing and/or high quality traits including the following:

- Agria
- Burmunk
- Cabernet Sauvignon
- Cabernet Franc
- Chardonnay
- Golubok
- Lemberger
- Madeleine Angevine
- Riesling
- Zweilgelt

Lastly, crosses are being made to investigate genetic components as well as to create parent plants carrying increased amounts of favorable alleles. To accomplish this, the following varieties have been used to create selfed populations:

- Syrah
- Madeline Angevine
- Golubok
- Petite Ami
- MN 1131
- MN 1094
- ES 12-06-18

Seed Production

Through the accelerated grape breeding protocols developed by Tyler Kaban of the University of Saskatchewan, year-round crossing and seed production within the greenhouse is possible. From our greenhouse crosses, 1,592 seeds have been produced to date. This is an average of approximately 37 seeds per harvested plant. With the increasing age of the parent plants comes increased seed production. When the

program was initiated in 2010 the number of seed per harvested vine was only ten to twenty. Currently, most vines harvested contain greater than fifty, with many over 125, and a few exceeding 250 seeds.

Of the 1,592 seeds collected, 1,433 are currently going through artificial or natural stratification in preparation for germination. These seeds will, depending on intended use, either be planted into the winter hardiness trial plot this spring, or evaluated in the greenhouse this summer. All remaining seed will be germinated for subsequent evaluations beginning this fall, winter, or next spring.

Seedling Production and Evaluation

In the fall of 2010, approximately 750 seedlings were planted in a Fargo seedling nursery to be tested for hardiness and acclimation traits. These seedlings were grown at NDSU from 24 crosses made by Mark Hart and Tyler Kaban. The crosses were both for short- and long-term goals containing inter-specific x inter-specific, inter-specific x *V. vinifera,* inter-specific x *V. riparia,* and *V. riparia* x *V. riparia* crosses. These seedlings will be evaluated for cold hardiness above the snow line to determine seedlings which are possibly hardy for the region. These hardy seedlings will be propagated for nurseries in the central and western part of the state and then move on to further testing including fruit quality and overall production characteristics.

Wild *V. riparia* Collection

To attempt to draw on greater diversity in adapted traits to North Dakota, new germplasm is being explored for its value to the breeding program. Diversity is the key to any good breeding program. Without diversity genetic gain cannot be realized. Currently only a select few *V. riparia* have been utilized in upper Midwestern breeding programs. It was deemed important to expand the diversity in *V. riparia* parentage in the NDSU breeding program. Investigation of wild vines has been initiated with collections in the following areas:

- Culbertson, MT
- Bismarck, ND
- Various local contributors from ND, MT, MN

These wild vines are being propagated into culture in the greenhouse for future evaluation of their diversity, acclimation and quality traits, and value as breeding parents.

GOALS AND OUTCOMES ACHIEVED

Pollen has been collected from 22 varieties of grapes

Variety	Collection Date
Baltica	June-10
Frontenac	June-10
MN 1200	June-10

Alpenglow	June-10
Frontenac Gris	July-10
Valiant	June-10
King of the North	June-10
ES 5-4-71	June-10
Bluebell	June-10
S. Seedless	June-10
Sipaska	June-10
Lacrescent	June-10
ES 10-18-14	June-10
ES 12-18-06	June-10
Clinton	June-10
ES 6-16-30	June-10
St. Croix	June-10
Marquette	June-10
Petite Pearl	May-10
SD 62-9-39	September-10
ES 8-2-43	September-10
Madeleine Angevine	November-3

Material donated by private breeders

Seed Parent	Pollen Parent	#Seeds	#plants
Riparia Girard 1-36-2	Regent	6	0
Manitoba Riparia 37	Regent	13	9
Riparia Girard 17-10	Calandro	39	33
MN 1095	MN 1131	200	141
Riparia 16-10	Solaris	27	17
(Riparia Manitoba X Seyval)	Mavo 98.16.01 (MN 1094 X Seyval)	22	17
Mavo 98.16.01 (MN 1094 X Seyval)	MN 1131	101	59
MN 1094	Mavo 99.13.02 (Sabrevouis X Frontenac)	97	67

All activities pertaining to the breeding process (asexual propagation, flower induction, vernalization, pollination, seed stratification & germination, pollen collection & storage, and culling of males and pistillate seedlings) were carried out year-round in the greenhouse. This allowed the pollination activity to be freed from the usual tight constraints caused by weather and the short outdoor bloom period associated with *Vitis*. The greenhouse methods provided us great flexibility in controlling bloom cycles and, by using the Saskatchewan techniques for forcing bloom in the same greenhouse-grown vines up to three times per year, allowed for highly efficient and rapid production of seed.

In 2010, 24 F_1 hybrid crosses were made. This was six below our initial goal of 30 due to the inability to successfully obtain germplasm from several sourcesforce flowering for several cultivars since the obtained plants were rather small. Our goal was to produce five to ten thousand seeds from crosses each year, which should result in about 3000-5000 seedlings to plant out each year. In 2010, approximately 2500 hybrid seedlings were transplanted in the greenhouse and then moved to the seedling nursery during early September. Seedling populations are being evaluated for hardiness and general adaptability (disease and pest resistance) in the traditional manner outdoors in a seedling nursery at the NDSU Experiment Station, which is considered Zone 4 for plant hardiness. Over 50% did not survive the winter. Surviving seedlings will be evaluated for another year (two years) before selecting hardy and adapted seedlings to be cloned and induced to fruit early in the greenhouse for fruit quality evaluation via microvinification, gas chromatography, and olfactometry.

In 2011, the entire cycle was repeated, with almost 40 F_1 hybrid crosses by the end of the year producing up to 8,000 seeds and approximately 4,000 seedlings, which will be planted during the fall. The additional seedlings, compared to the proposed 2,500 seedlings resulted from the additional crosses, which produced more seeds. The increase in the number of crosses resulted from our ability to obtain more flower clusters on female parent plants. This was attributed to our transplanting of these plants into larger containers and moving vernalized plants to another greenhouse without benches.

In 2012, the breeding cycle will be repeated. It is anticipated that at least 30 F_1 hybrid crosses will be made from the germplasm previously described. Seeds from these crosses will be collected, stratified, germinated, and grown in the greenhouse before transplanting into the field nursery. It is anticipated that at least 2,500 hybrid seeds will be planted in greenhouse and moved to field nursery in 2012.

In 2013, the breeding cycle will again be repeated. It is expected that at least 30 F1 hybrid crosses will be made from the germplasm previously described. Seeds from these crosses will be collected, stratified, germinated, and grown in the greenhouse before transplanting into the field nursery. Therefore, at least 2,500 hybrid seeds will be planted in greenhouse and moved to field nursery in 2013.

We will not be able to make the proposed F_2 hybrid crosses in 2014. The definition of the F_2 generation is the resulting progeny from the selfing of an F_1 population. Under this definition the use of F_2 plants in a grape breeding program is not beneficial. We have selfed several progeny from an F_1 population in grapevine and found it to be difficult to impossible. Progeny of self-fertilization in grapevine were excessively low in vigor, sickly, and most died before reaching the reproductive stage. Consultation with other grape breeders in the U.S. reinforced our results and suggested that F_2 plants should not be utilized within a grape breeding program.

Another important reason why F_2 populations are not utilized within grapevine breeding is the heterozygous nature of grapevine. Most crops are in some way inbred. In crops such as wheat and soybeans inbred lines are used as parents. In an inbred line, each individual is homozygous at each locus. When an inbred line is crossed with another inbred line the resulting F_1 population is entirely the same because it has

only one gamete option from each parent at each locus. This means that each individual within the F_1 generation is heterozygous. When these heterozygous F_1 lines are then crossed, the resulting population segregates showing the most genetic diversity in the progeny of the F_2 population. In grapevine parents are not inbred. This causes parent material to be heterozygous at many loci prior to any crossing. This means that when the two initial parents are crossed segregation of traits occurs in the initial F_1 generation. This makes a grapevine's F_1 generation similar to an inbred crop's F_2. Since a grapevine is usually asexually propagated, there is no need to inbreed the F_1 individuals to obtain stable lines. This means that individuals of the F_1 generation can be evaluated for their agronomic value and individuals found to be elite can be directly released. Therefore, an F_2 generation is not required to release varieties from a grape breeding program.

Potential clones will be selected following fruit production in the greenhouse as well as planted in grower vineyards for further evaluation and data collection. These secondary nursery plantings should begin in 2014. Fruit production in secondary nurseries should begin by 2015 and cultivar selection should follow soon after fruit production. Once vines begin to produce fruit, microvinication will be used to eliminate progeny with fruit characteristics less than our red wine grape standard of 'Marquette' and the white wine grape standard of 'Frontenac Gris'. With microvinification, the entire winemaking process is virtually the same, but on a much smaller scale. Instead of using 100 or 200 gallon fermenters, small flasks will be used for the 200 gram samples that will come from individual plants. Industry standards will be included for comparison. Soluble solids and titratable acidity will be adjusted so that all samples have identical sugar and acid levels. Multiple clusters on a vine enable replication and statistical analysis of the data collected from each sample. Fruit from top candidates from the microvinification process will be collected from field grown vines for comparison approximately 2 years later for vinification of larger samples. Together there should be ample information for release decisions. Therefore, we are well on our way to successfully developing hybrids; however due to the time limitations previously discussed and the fact that for most pubic breeding programs it takes approximately 15 years from making a cross to the time of release, we will be unable to have a successful hybrid developed by 2015, but hope to have at least one release a couple of years later.

Eight year plan

	2010	2011	2012	2013	2014	2015	2016	2017
Cross parent vines (30 crosses)	X	X	X	X	X	X	X	X
Grow seedlings in greenhouse (2500)	X	X	X	X	X	X	X	X
Transplant to field for evaluation (2500)	X	X	X	X	X	X	X	X

Select and propagate most promising			X	X	X	X	X	X
Grow in greenhouse for fruit production				X	X	X	X	X
Assess fruit and wine quality (microvinification)					X	X	X	X
Use best seedlings in multiple crosses							X	X
Side by side field comparisons to standards for introduction decisions							X	X

BENEFICIARIES

Even though grape breeding activities have really only just begun, the beneficiaries of this project include grape and wine enthusiasts throughout the state, current and future growers, and once a hardy red and white wine grape is developed, the entire state will benefit.

LESSONS LEARNED

Refinement of the Breeding System

During this first season of the NDSU Grape Breeding program much effort has also been put into getting the breeding system implemented and running efficiently. For the crosses to be made, many projects were conducted such as adapting the greenhouse space, learning the timing and techniques required, as well as finding and growing the parent plants to be utilized. Over the past 3 months the greenhouse based breeding system has become a continuous loop starting with the induction of flowering, pollen collection, emasculation, crossing, growing of fruit, seed collection, to re-induction of flowering once again. Currently, vines are available in all stages of this system allowing for the continuous production of seed on a daily basis. Overall, the adjustments that have been made to the process suggested by Tyler Kaban have allowed for increased production at NDSU. The improvements have resulted in increased seed production, increased time efficiency, as well as better utilization of space.

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ADDITIONAL INFORMATION

- Greenhouse grape breeding pictures

Flower cluster on *Vitis riparia* vine in greenhouse.

Ripe cluster from cross made in greenhouse

Unripe cluster on *Vitis riparia* used as parent.

Flower on *Vitis vinifera* used as parent.

Ripe cluster just before seed harvest.