NORTHERN GROWN CROPS IN EXPANDING HEALTH FOOD MARKET

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NORTHERN CROPS INSTITUTE

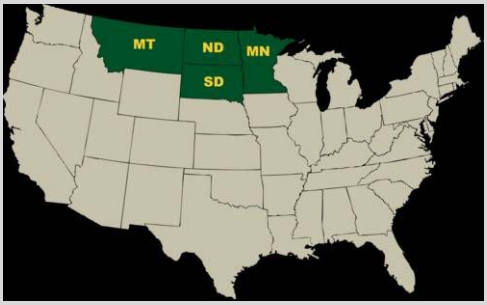
Main Areas of Expertise:

- Educational Courses
- Technical Services

NORTHERN CROPS INSTITUTE

Four state collaboration (Minnesota, Montana, North Dakota, South Dakota) based at North Dakota State University in Fargo, ND. (Century Code 4.1-15)

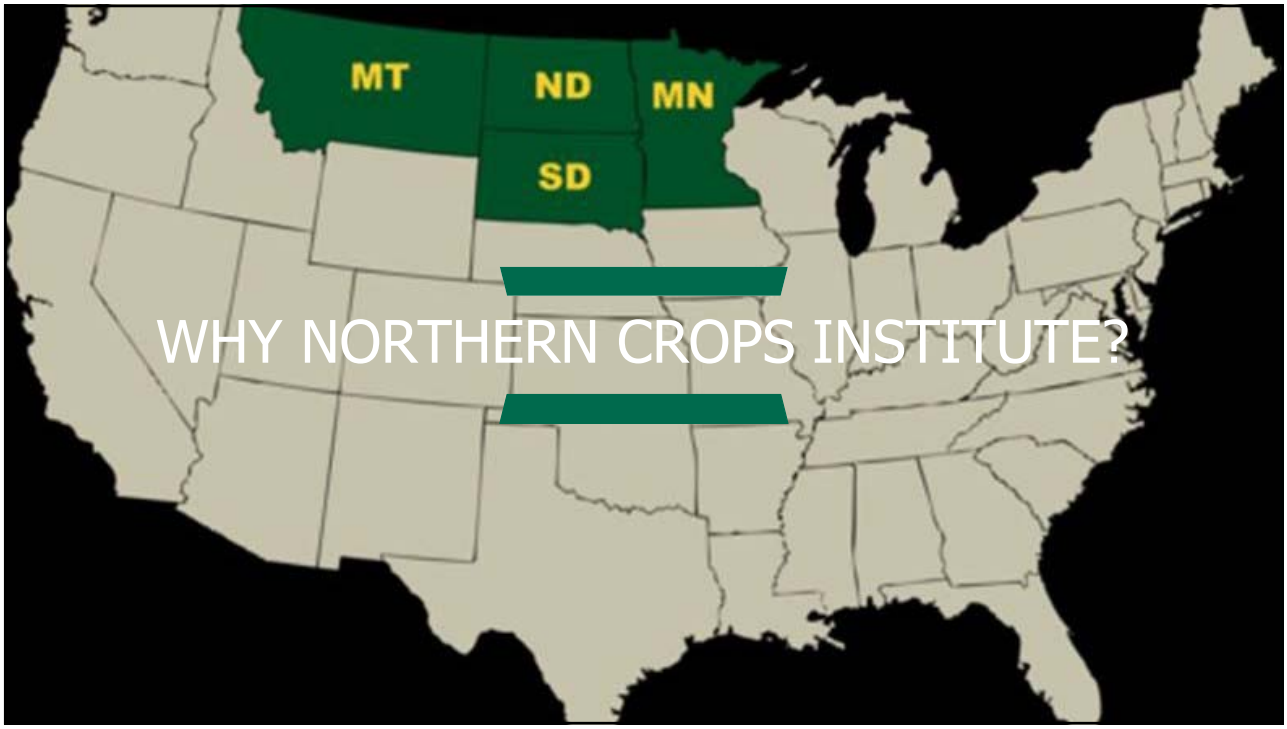
- 35 Year History
- Governed by Northern Crops Council
- Global Recognition and High Level of Trust
- Strong Core Facilities



NORTHERN CROPS INSTITUTE

We believe that:

- Crops grown in the northern-tier of the U.S. are valued by discriminating world wide customers and will stand the test of quality against competitors.
- Respect for all cultures, economic status and individuality results in valuable relationships.
- Effective partnerships and teamwork are critical to accomplish our mission.
- Adapting to new trends and technologies is necessary to remaining vital to the agricultural industry.



WHY NORTHERN CROPS INSTITUTE?

Ten Leading States and North Dakota's Rank

Item	1	2	3	4	5	6	7	8	9	10	North Dakota's rank	Percent of nation [1]
	Crop production – 2017											
Wheat, all	KS	**ND**	WA	MT	OK	ID	CO	MN	TX	OR	2	13.7
Spring	**ND**	MN	MT	ID	WA	SD	OR	CO	UT	NV	1	49.9
Durum	**ND**	MT	AZ	CA	ID	SD					1	52.7
Winter	KS	WA	OK	CO	TX	MT	ID	NE	OR	MO	35	(Z)
Barley	ID	MT	**ND**	CO	WY	MN	WA	PA	OR	AZ	3	17.5
Oats	MN	WI	**ND**	SD	IA	TX	PA	MI	NY	NE	3	9.4
Sunflower, all	SD	**ND**	CO	KS	NE	MN	TX	CA			2	32.1
Oil	SD	**ND**	CO	KS	MN	CA	TX	NE			2	33.7
Non-oil	SD	**ND**	NE	KS	TX	CO	MN	CA			2	22.8
Canola	**ND**	OK	MT	WA	MN	KS	ID	OR			1	81.5
Soybeans	IL	IA	MN	NE	IN	MO	OH	SD	**ND**	KS	9	5.5
Flaxseed	**ND**	MT	SD								1	89.4
Safflower	CA	ID	MT	SD	UT	**ND**					6	2.7
Corn, grain	IA	IL	NE	MN	IN	SD	KS	OH	MO	WI	11	3.1
Silage	WI	CA	PA	NY	MN	IA	ID	SD	MI	KS	21	1.2
Dry edible beans, all	**ND**	MI	NE	MN	ID	WA	MT	CO	CA	WY	1	34.6
Pinto	**ND**	NE	CO	ID	WY	MN	WA	MT			1	61.8
Navy	**ND**	MI	MN	ID	WA						1	39.6
Dry edible peas	**ND**	MT	WA	NE	SD	ID	OR				1	52.1
Lentils	MT	**ND**	WA	ID							2	29.1
Potatoes, All	ID	WA	WI	**ND**	CO	OR	MN	MI	CA	ME	4	5.7
Sugarbeets	MN	ID	**ND**	MI	NE	MT	CA	CO	WY	OR	3	18.2
Hay, all	TX	NE	KS	CA	OK	MO	KY	ID	MT	SD	15	2.7
Alfalfa	CA	ID	MT	NE	MN	CO	SD	WI	IA	AZ	15	3.4
Other	TX	MO	OK	KY	KS	TN	NE	VA	PA	AR	14	2.2

Northern grown crops
=Anything grown in the four state region
(including minor crops such as Amaranth, millet, triticale, sorghum, etc.)

VERSATILE PROCESSING CAPABILITIES PILOT SCALE PROCESSING

- Flour Milling
- Extrusion
- Oil Pressing
- Hexane Extraction
- Soy Foods
- Feed Milling
- NIR
- Laboratory Analysis
- Pasta Press
- Baking Facilities
- Canning
- Quality Analysis
- Hammer Milling
- Pearling

***These Labs/Equipment Used Both For Industry and Education

WHAT ARE PULSES?

Edible seeds of plants in the legume family

- Peas
- Beans
- Lentils
- Chickpeas/garbanzo beans
- Faba beans
- Lupin beans
- Pigeon peas

Many activities involving pulses

- International year of pulses (2016)
- World pulse day (Feb. 10)

BENEFITS OF PULSES

- Sustainability
- Nutrition / Health benefits
- Innovation

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- **Sustainability**
- Nutrition / Health benefits
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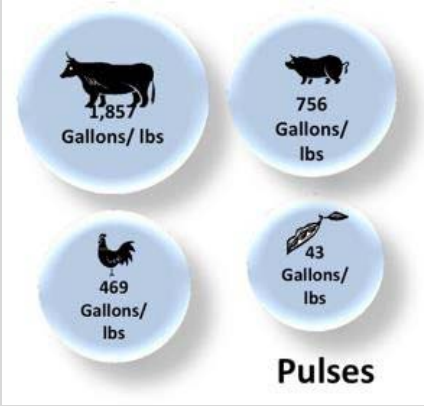
BENEFITS OF PULSES: SUSTAINABILITY

- Plant fixing nitrogen
- Lower energy requirement
- Increased water use efficiency



Hoekstra and Chapagain (2010)

BENEFITS OF PULSES

- Sustainability
- **Nutrition / Health benefits**
- Innovation

BENEFITS OF PULSES: NUTRITION

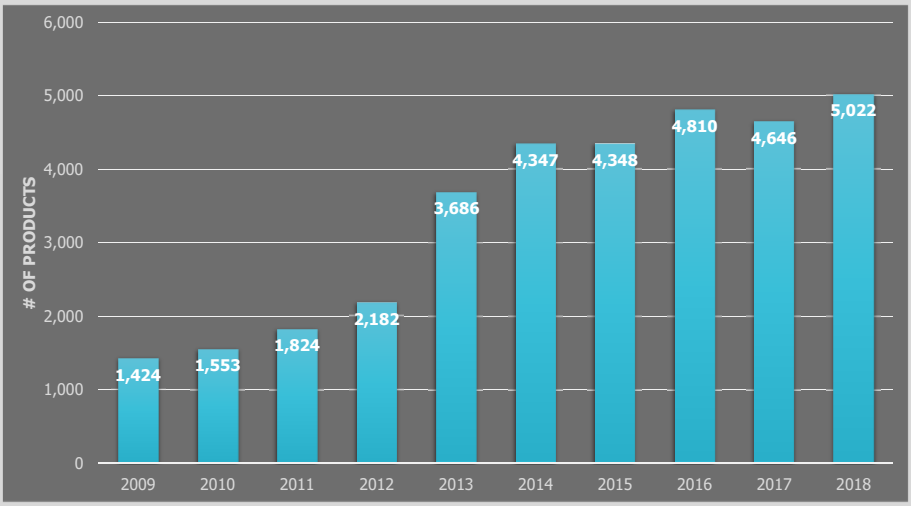
- ✓ High **protein**
- ✓ High **dietary fiber**
- ✓ High in **antioxidants**
- ✓ High in **micronutrients**
- ✓ Lower **glycemic index scores** compared to cereals
- ✓ Low **allergen**
- ✓ **Gluten-free**
- ✓ Non-**GMO**

BENEFITS OF PULSES

- Sustainability
- Nutrition / Health benefits
- **Innovation**

BENEFITS OF PULSES: INNOVATION

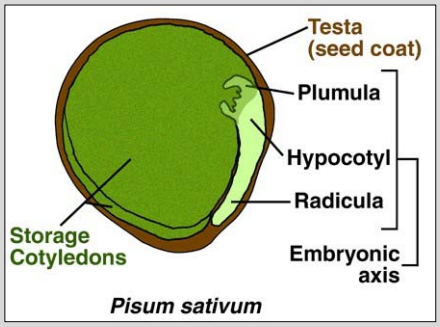
Number of product launched containing pulses in past 10 years



Source: Mintel GNPD (Feb 2019)

INNOVATION: PULSE INGREDIENTS

- ✓ Whole seed
- ✓ Splits/ dehulled
- ✓ Flakes
- ✓ Pulse flours
  - Raw/Precooked
  - Splits/Whole
- ✓ Fractionated products
  - Protein concentrate/Isolate
  - Starch concentrate/Isolate
  - Inner fiber/Outer fiber



PULSE RELATED PROJECTS

- Development of low glycemic index foods by incorporating pulse ingredients into cereal-based products: Use of in vitro screening and in vivo methodologies. 2017. Cereal Chem. 94:110-116
- Collection of glycemic index data to support the marketing of pulse and pulse ingredients (publication yet to be submitted)
- Physicochemical properties of hammer-milled yellow split pea (*Pisum sativum L.).* 2018. Cereal Chem.
- The latest study just initiated
  - Keyword – Sourdough, Whole wheat, Irritable bowel syndrome, pulse flour

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EXPERIMENTAL DESIGN

Ingredients

- Pulse flour
  - Split yellow pea (YP)
  - split green pea (GP)
  - decorticated green lentil (GL)
  - decorticated red lentil (RL)
- Pea protein concentrate
- Pea protein isolate
- Pea fiber

EXPERIMENTAL DESIGN CONT'D

Methods

- Product development: Control and pulse variant (i.e. samples comparable to control but partially replacing wheat flour with pulse ingredients)
- All samples were screened for *in vitro* GI, total starch and resistant starch
- 10 products (5 control, 5 pulse variant) were selected for *in vivo* with 10 healthy subjects (5M, 5F; 36±14y, 23±4kg/m^2)
- Nutrition analysis was conducted to determine available carbohydrate content
- Palatability test was conducted with subjects used in the *in vivo* test (non-trained)

RESULT – PRODUCT DEVELOPMENT

- A total of 94 products were formulated and tested including bread, pasta, crackers, extruded snacks, cookies, cereal bars and muffins.
- Products selected for *in vivo* GI were:
  - Focaccia (16% green lentil flour)
  - Pasta (50% red lentil flour)
  - Cracker (9% pea protein isolate)
  - Granola bar (9% green lentil flour & 4% puff)
  - Cookie (11% green lentil flour, 0.6% pea protein concentrate and 0.9% pea fiber)

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RESULT – IN VITRO GLYCEMIC INDEX

	in vitro GI	LSD	Total Starch	LSD	Resistant Starch	LSD
Focaccia Control	81 ± 0.3	14.5^{NS}	59 ± 8.4	9.92^{NS}	1.1 ± 0.1	0.59^{NS}
Focaccia GL	79 ± 1.2		48 ± 2.2		1.8 ± 0.4	
Pasta control	111 ± 3.1	8.4	70 ± 1.8	2.64	0.6 ± 0.04	1.08
Pasta RL	102 ± 1.3		58 ± 2.0		1.7 ± 0.5	
Cracker control	75 ± 7.3	12.3	47 ± 3.9	5.53	0.1 ± 0.1	0.49
Cracker YP	56 ± 2.5		34 ± 2.6		0.3 ± 0.05	
Granola Control	60 ± 5.9	8.3^{NS}	25 ± 0.9	1.34	0.3 ± 0.01	0.24^{NS}
Granola PP	48 ± 0.5		21 ± 0.1		0.2 ± 0.06	
Cookie Control	70 ± 4.8	9.9	25 ± 0.5	3.93	0.3 ± 0.2	0.66^{NS}
Cookies YP	58 ± 2.0		20 ± 0.04		0.5 ± 0.2	

[1]-Green lentil, [2]-Red lentil, [3]-pea protein isolate, [4]-Pea protein concentrate, [5]-Pea fiber
^{NS} indicate that there is no significant differences

- Mean reduction of 10.8 ± 2.7 *in vitro* GI units between control and pulse

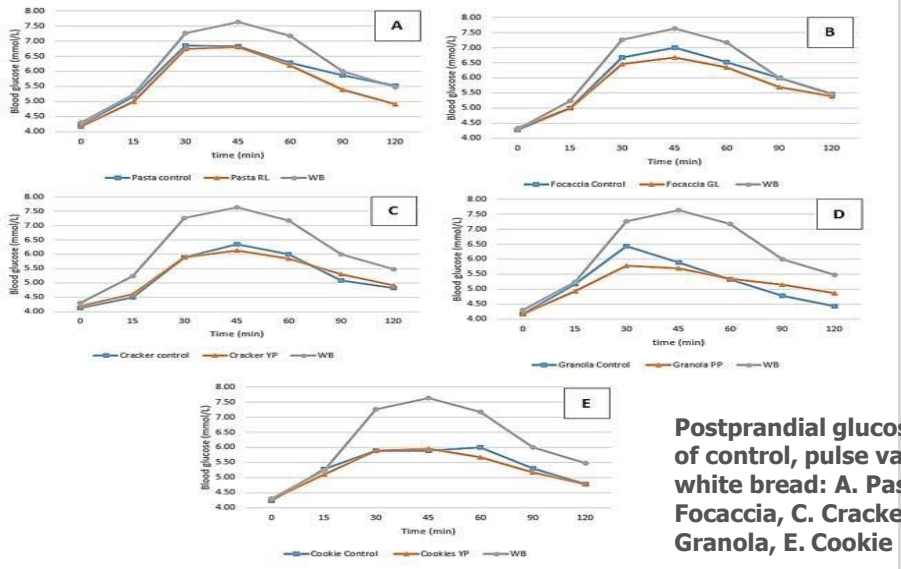
RESULT – IN VIVO GLYCEMIC INDEX

	In vivo GI	Glycemic load	GI category
Focaccia Control	61 ± 6	31	Medium
Focaccia GL[1]	53 ± 5	27	Low
Pasta control	61 ± 5	31	Medium
Pasta RL[2]	55 ± 8	28	Low
Cracker control	46 ± 4	23	Low
Cracker YP[3]	42 ± 3	21	Low
Granola Control	35 ± 4	18	Low
Granola PP[4]	35 ± 5	18	Low
Cookie Control	42 ± 4	21	Low
Cookies YP[5]	38 ± 3	19	Low

[1]-Green lentil, [2]-Red lentil, [3]-pea protein isolate, [4]-Pea protein concentrate, [5]-Pea fiber

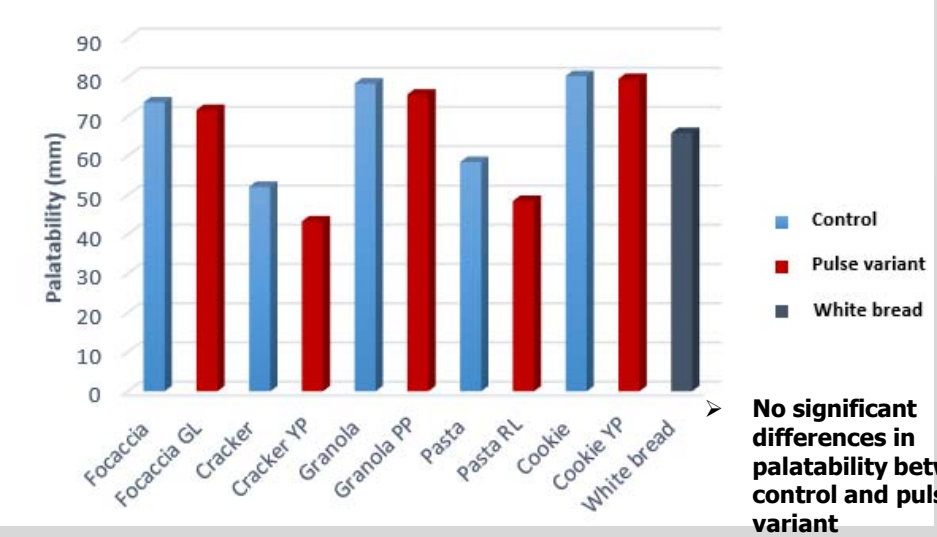
- Mean reduction of 4.8 ± 2.6 in vivo GI units between control and pulse

AREA UNDER THE CURVE



Postprandial glucose response of control, pulse variant and white bread: A. Pasta, B. Focaccia, C. Cracker, D. Granola, E. Cookie

PALATABILITY



- **No significant differences in palatability between control and pulse variant**

CONCLUSION

- Pulse fortification reduced the in vitro and in vivo GI by 10.8 ± 2.7 and 4.8 ± 2.6 units respectively
- Extent of result varied depending on products and processing methods
- Substituting wheat with pulse ingredients reduces GI without changing palatability

THANK YOU

Brian Sorenson

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