Field Pea Production Workshop

Culbertson, NE

November 4, 2016

Program Agenda

- **8:30 AM (Central)-Welcome and Registration**
- **9:00-9:30 AM-Market Updates**

  Sponsor/Exhibitor updates

  Ben Dutton-A brief look at data and trends that favor the production of field peas
- **9:30-10:45 AM-Why Grow Field Peas**

  Strahinja Stepanovic-Outline and rationale

  Rodrigo Werle-Soil nutrients, microbial activity, and soil infiltration

  Julie Peterson-Beneficial insects

  Tony Adesemoye-Beneficial microbes and diseases to watch for

  Chuck Burr and Daran Rudnick-Water use, yield, yield quality, and economics

  Lucas Haag (K-State)-Field pea as fallow alternative on the Central High Plains
- **10:45-11:00 AM-BREAK**

  Sponsors/Exhibitors

  Pet Food Exhibit

  Breakfast cake made from pea flour
- **11:00 AM-Noon-Growing Field Peas-Part I**

  Dipak Santra-Field pea varieties for Nebraska

  Lucas Haag (K-State)-Kansas variety testing and seeding rate studies

  Rodrigo Werle and Strahinja Stepanovic-Seeding rates, seedling depth, and inoculants

  Cody Creech-Herbicide options in field peas
- **Noon-12:45 PM-LUNCH**

  Nancy Frecks-Nutrition facts about field peas
- **12:45 PM-2:00 PM-Growing Field Peas-Part II**

  Ron Meyer (CSU)-Peas grown for forage

  Carrie Ann Eberle (UW)-Winter pea performance in Wyoming

  Farmer Panel–Steve Tucker (Venango, NE), Brad Hansen (Hemingford, NE),

  Dennis Demmel (Ogallala, NE), Jordan Dunker (Atwood, KS)
- **2:00 PM-3:00 PM-Hands-on Exercise**

  Matt Stockton-Selecting most profitable crop rotation
- **3:00 PM-Adjourn**

  Thank you for attending!

TRENDS FAVORING DEMAND FOR FIELD PEAS

EXTENSION

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SUMMARY

- Strong growth in adoption of plant-based diets.
- Strong growth in health product sales including protein powders, bars & ready to drink shakes.
- Strong growth in in gluten-free product sales.
- Most processed pea inputs sourced from China with peas produced in Canada → US manufacturers want US-based inputs

EXTENSION

SHIFT TOWARD PLANT-BASED PROTEINS

In 2006, 6% of U.S. population self-identified as vegan.

In 2016, between 26% and 40% of the U.S. population self-identify as eating on the "flexitarian spectrum."

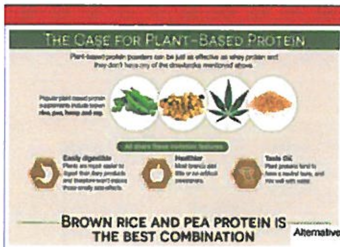
Vegan	Vegetarian	Flexitarian
Only plants	Primarily plants + eggs & dairy	Less meat

EXTENSION

HEALTH PRODUCT GROWTH

Powder	Protein Bars	RTD	Other Protein
forecasted CAGR	forecasted CAGR	forecasted CAGR	forecasted CAGR

EXTENSION

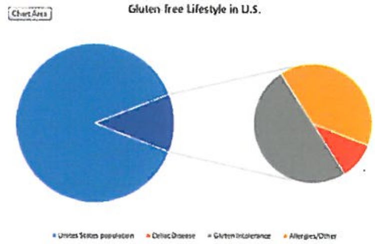


Alternatives to milk proteins lack scale but are gaining steam

- Milk proteins alternatives are less common but growing quickly
- Plant proteins cater to health-and wellness-focused consumers
- Soy has limited reach in sports nutrition
- Pea, rice and hemp are emerging as plant-based leaders

GLUTEN-FREE LIFESTYLES

Approximately 40 million people in the U.S. live a gluten-free lifestyle due to Celiac Disease, gluten intolerance, allergies or other reasons.



EXTENSION

SHOPPING BEHAVIORS

- 55% spend 30% or more on their grocery budget for gluten free foods
- 68% shop at three or more stores per month to find gluten-free foods
- When asked if they could find the same products at all the following stores where would they most prefer to shop for gluten-free foods:

71% grocery store (where I shop for most of my family's groceries)

9% independent natural or health food store

8% mass merchandiser

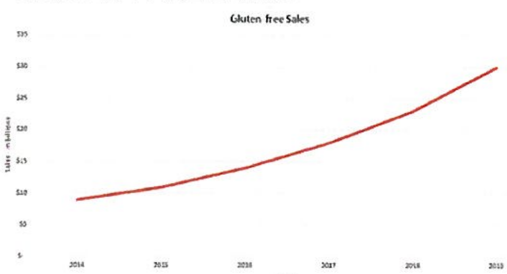
7% natural food chain (e.g. Whole Foods)

5% club store (i.e. Sam Club)

0.1% drug store

N | EXTENSION

GLUTEN-FREE SALES



Between 20% and 30% growth expected through 2019

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PEA DERIVATIVE SUPPLY CHAIN

100% of survey participants buy pea inputs from China (fiber, starch, protein)

100% of survey participants said they would prefer to buy from U.S. producers if quality and price were comparable due to (1) inconsistent quality of Chinese product & (2) ease of working with U.S. producers.

N | EXTENSION

WHY GROW FIELD PEAS?

Outline and Rationale – field pea vs fallow

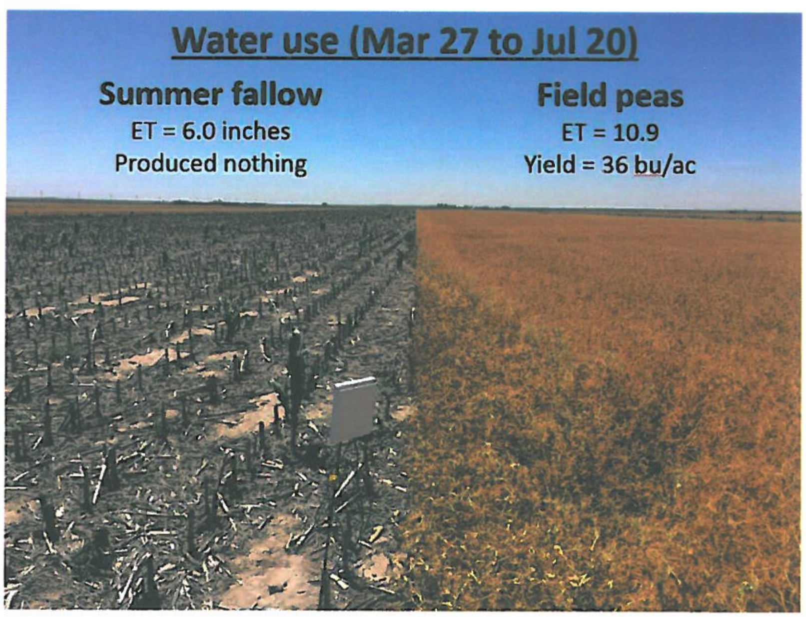
Strahinja Stepanovic, Rodrigo Werle, Julie Peterson, Tony Adesemoye Chuck Burr, Daran Rudnick

The problem. Using cover crops to improve soil quality in the semiarid environment of western Nebraska, where water is the main yield limiting factor, may not be economically justified. Over the past 30 years many farmers have adopted no-till summer fallow and no residue removal as important water conservation practices under wheat-corn-fallow or wheat-fallow rotations. However, evolution of herbicide-resistant weeds and absence of new herbicide Modes of Action (MOA) in the past 25 years have prevented many farmers in western Nebraska to sucessfully control the weeds during summer fallow period and avoid excessive soil water extraction, which can severly impact succeding crop.

The potential solution. Replacing no-till summer fallow with a cool season legume crop such as grain-type field peas may: (1) reduce the number of herbicide applications, potentially delay the evolution of herbicide-resistant weeds, and preserve no-till summer fallow as a valuable water conservation practice; (2) provide rotational benefits through nitrogen (N) fixation, improve soil physical and chemical properties, and increase biodiversity above and below ground; and (3) generate profit. The trade-offs are that field peas may deplete soil water and potentially reduce the yield of succeeding wheat crop (yield penalty = 5-6 bu/ac-inch), especially in dry years.

Rotation Study. Comparing impact of **field peas vs no-till summer fallow** on:

1. Soil - soil nutrient cycling, soil microial activity, soil infiltration and soil agregation
2. Beneficial insects
3. Beneficial soil microorganizms and bilogical control agents
4. Water use
5. Yield and yield quality of succeeding wheat crop
6. Profitability



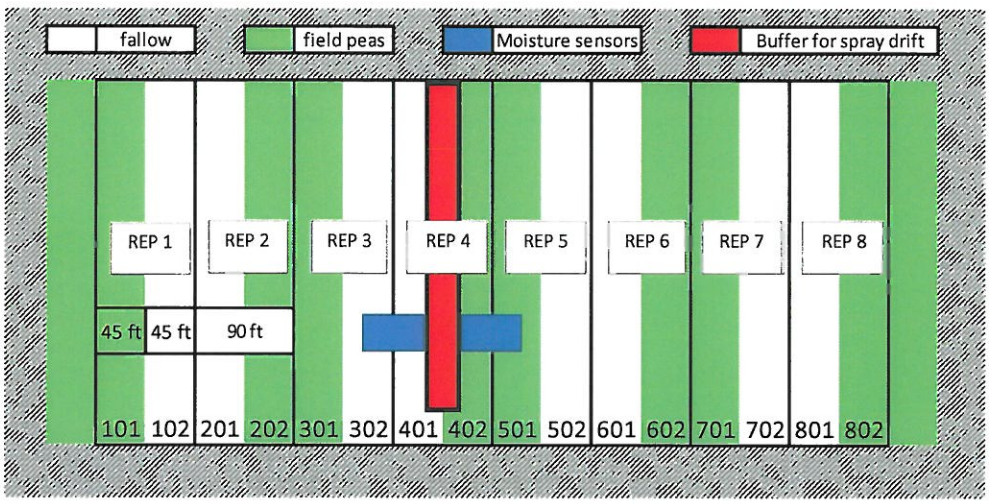
ROTATION STUDY – field pea vs fallow

Study site and cultural practices

The study was conducted in the Spring of 2015 on a cooperators' field located in Chase County near Enders, NE. Field site was historically operated under no-till in a wheat-corn-fallow rotation with Blackwood loam as the predominant soil type.

The strip trial was set as pairwise (side-by-side) comparison of field peas vs summer fallow with 8 replications (total of 18 strips, each being 60 ft x 2,650 ft^2). Field peas cultivar Salamanca was inoculated (Cell Tech liquid inoculate) and drilled (10-inch drill) in strips at 180 lb/ac seeding rate on March 27, 2015. There was good establishment and nodulation (Figure 1), and the study was harvested on July 20, 2015. Winter wheat was planted across the whole field on Sep 14, 2015 and it was harvested in strips on July15 2016 to evaluate rotational effects of treatments on wheat yield and yield quality.

Same study was repeated in 2016 at two additional sites (south Chase and northeast Perkins County).



SARE
Sustainable Agriculture Research & Education

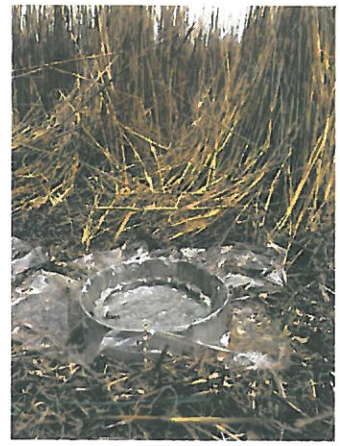
SARE funded 2 grants to continue Rotation studies in 2016-2020:

- SARE Partnership Grant ($30,000) – Partnering with farmers to conduct on-farm research studies
- SARE Research and Education Grant ($200,000) – Investigating feasibility of production of field peas in different precipitation zones across the state of NE.

ROTATION STUDY – field pea vs fallow

Soil nutrient cycling, soil microbial activity, and soil infiltration

Strahinja Stepanovic, Rodrigo Werle



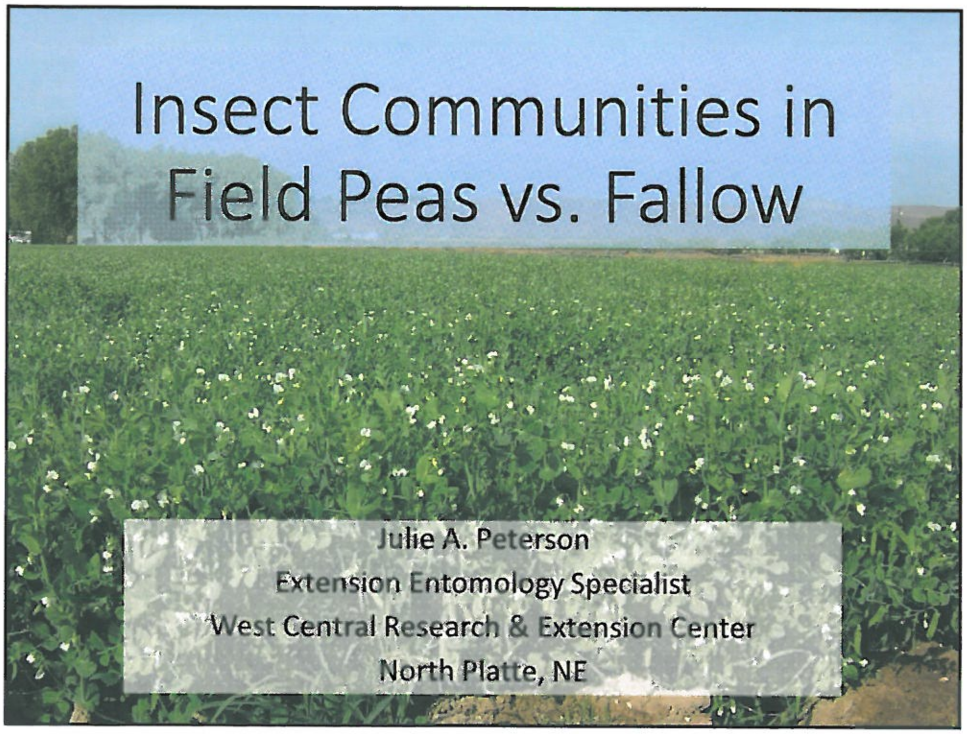
- Concentrations of soil nutrients (N, P, and K) did not differ between field peas and fallow at any time during 2-year rotation study.
- Solvita test after wheat planting in the fall and in the spring had higher soil-microbial activity and annual N release in areas of the field where field peas were grown. Solvita test did not differ between field pea and fallow after wheat harvest.
- Rotational benefit from N being fixed from field pea may be already scavenged by wheat or is likely to be seen in next rotational crop (corn/sorghum).
- The initial soil water infiltration (1 inch; see picture) was collected after wheat harvest by taking 4 subsamples in 6 replications; It took 174 sec for fallow treatment vs 87 sec for field pea treatment.

Table 1. Seasonal changes in soil nitrate (NO3-N), phosphorous (P), potassium (K), and microbial activity (Solvita test) for the field peas and fallow in 2015 Rotation study in Chase Co.

Date*	Treatment	Depth	NO3-N		P	K	Solvita	
		inches	ppm	lb/ac	ppm	ppm	CO2-C ppm	lb of N /ac/year
27-Mar-15	Baseline	0-8	8.5	20	23	389		
		0-8	8.1	19	26	365		
14-Sep-15	Field pea	0-4	16.5	20	69	515		
		5-8	11.1	13	33	451		
	Fallow	0-4	19.3	23	61	598		
		5-8	8.8	11	21	488		
16-Oct-15	Field pea	0-12	16.8	60	24	424	52.27	42.00
		12-24	11.2	40	14	361		
		24-36	12.0	43	13	442		
	Fallow	0-12	26.4	95	90	431	27.72	22.00
		12-24	9.7	35	9	340		
		24-36	13.0	47	9	519		
16-Mar-16	Field pea	0-12	2.6	9	37	514	71.63	57.00
		12-24	1.5	5	9	344		
		24-36	2.9	10	2	452		
	Fallow	0-12	2.0	7	41	457	59.74	48.00
		12-24	2.2	8	4	338		
		24-36	1.8	6	4	506		
30-Aug-16	Field pea	0-4	10.6	13	46	609	11.69	9.00
		0-12	4.0	14	22	552	8.50	7.00
		12-24	0.1	0	2	347		
		24-36	0.1	0	2	428		
	Fallow	0-4	7.4	9	70	623	14.00	11.00
		0-12	4.0	14	37	479	14.00	11.00
		12-24	1.3	5	11	323		
		24-36	1.1	4	2	449		

*27-Mar-15 (prior to field pea planting), 14-Sep-15 (after field pea harvest, before wheat planting), 15-Oct-16 (fall after wheat plating), 16-Mar-16 (wheat in spring), 30-Aug-16 (after wheat harvest)

Insect Communities in Field Peas vs. Fallow



Julie A. Peterson
Extension Entomology Specialist
West Central Research & Extension Center
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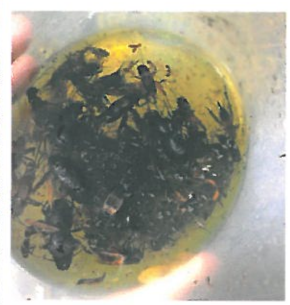
Insect Sampling

- Pitfall traps:
  Collect arthropods that are actively moving along the ground



- Sweep nets:
  Collect arthropods that are up in the vegetation, crawling, flying, or sitting on plants

Results: Pitfall Traps 2015

- Field pea plots supported more insects, particularly beneficial predators, than the fallow plots




		Fallow	Field Peas
Predators	Wolf Spiders	2.1	4.8
	Flat Bark Beetles	1.7	20.6
	Rove Beetles	6.3	17.0
	Ants	1.1	4.0
Parasitoids	Chalcid Wasps	0.7	1.5
Decomposers	Dung Beetles	0.1	2.6
	Carrion Beetles	1.9	20.6
	Minute Brown Scavenger Beetles	53.2	15.9
Potential Pests	Click Beetles (adult wireworms)	2.3	8.6
	Sap Beetles	10.2	110.2
	Leafhoppers	0.4	10.4
	Bark Lice	31.7	1.9




- The only insects that were more abundant in fallow plots were minute brown scavenger beetles and bark lice

Results: Pitfall Traps 2016

- In the wheat field following fallow and field peas, only one insect group showed a difference due to treatment:

		Fallow	Field Peas
Potential Pests	Aphids	31.8	1.6

Results: Sweep Nets 2015

- Predators were more abundant in field pea plots vs. fallow plots

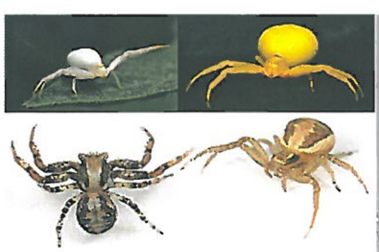
		Fallow	Field Peas
Predators	Crab Spiders	0.0	1.4
	Long-jawed Orb Weaver Spiders	0.0	0.8
	Hover Flies	0.0	0.9



Results: Sweep Nets 2016

- In wheat the following year, some predators and parasitoid wasps were more abundant in field pea plots vs. fallow plots

		Fallow	Field Peas
Predators	Crab Spiders	2.0	3.1
	Parasitoid Wasps	1.3	2.0




Summary

- In 2015, field peas seem to support higher numbers of insects and more diversity of insects
  - This means that both the beneficial and the harmful insects are probably benefitting from a pea field planting vs. fallow
  - In our study, there were more positive effects for beneficials than for pests
- In 2016, aphids were lower and some natural enemies were higher in wheat following field peas

Beneficial microbes and diseases that can impact peas production

Tony Adesemoye, Plant Pathology Specialist

The study to compare the impacts of wheat-peas to wheat-fallow rotation for the possibility of using field peas as an alternative to no-till summer fallow in western Nebraska is ongoing. This study continues to be very important and timely because in the last few years, there has been a continuous increase in the production/acreage of field peas in the state as well as nationally. As adoption of planting peas continue to expand in the area, it not yet clear what the effect would be on soil health in terms of microbial diversity, especially specific beneficial microorganisms. Whatever effects peas might have on soil health, clearly, that will have an impact on the subsequent wheat crop. It is also not clear what pathogens will affect the production of peas in this region and to what extent the yield of peas might be affected by the pathogens. My component of this study was intended to answer these questions on beneficial microorganisms and pathogens and it will be discussed in this section.

Sample collection

Plant samples were collected from two locations in western Nebraska – (1) Field near Enders and (2) Field near Grant. The design of the study in each of these two fields were similar, involving large-scale strip trial and pairwise (side-by-side) comparison of field pea-wheat vs fallow-wheat with 9 replications. A full description of the experimental design for these fields can be found in Rotational study outline of this booklet. Location 1 near Enders was in the second year of rotation for wheat and both wheat and pea samples were collected from the location. However, location 2 near Grant was in the first year and only pea plant samples were collected.

Plant analysis for beneficial microorganisms

Small pieces of root were cut, heat-treated, and plated onto an appropriate laboratory medium (Tryptic soy agar) to allow the isolation of beneficial *Bacillus* species. This was done for wheat samples near Enders but also peas collected from Enders and Grant locations. Many microbial isolates were recovered and have either been identified through 16S rDNA or in the process of identification. So far, more diverse species were recovered in the wheat plants following peas than in the wheat plants after fallow (Table 1).

Table 1: Isolates recovered from wheat rhizosphere

Fallow-Wheat	Pea-Wheat
Bacillus megaterium (multiple strains)	*Bacillus megaterium* *Bacillus pumilus* *Lysinibacillus fusiformis*

Extraction of mycorrhiza spores showed an average count of 16.5 in pea rhizosphere compared to average count of 8 from the fallow plots near Enders. Next year when wheat goes into this year's pea plots, it will be seen if these population differences remains the same for the wheat treatments. Also, it will be seen if the bacteria that were isolated from peas this year remain persistent in the subsequent wheat roots next year. No rhizobacteria was isolated from the fallow plots.

Plant analysis for pathogens

Visual observation of fields were done but there was no visible symptoms of foliar diseases on peas in any of the fields. Soilborne pathogens that have been reported in other places in pea production include species of *Fusarium*, *Rhizoctonia*, *Pythium*, and *Aphanomyces*. Samples looking somewhat weak were collected in our field plots to test for these soilborne pathogens. Only *Fusarium* species was recovered from the samples collected in location 2. The isolate was tested but did not cause disease on peas. In location 1, there was no significant difference in terms of foliar disease levels between wheat samples following peas compared to wheat samples following fallow. Additionally, wheat samples were analyzed for *Rhizoctonia* and *Fusarium* and no pathogenic isolate was recovered.

Conclusion

Based on the data so far, it appears that planting pea may positively affect the diversity of microorganisms that could be beneficial on the next year's wheat compared to if pea was not planted but there was a fallow period before wheat. The beneficial bacteria recovered from the wheat has the potential to stop or reduce the impact of pathogens.

		Field Peas Economics			
				Field Peas	Fallow
Location	input	product	rate	cost ($/ac)	cost ($/ac)
2015 CP	insurance	crop insurance	$69.41/ac	7.22	
2015 CP	planting	NA	NA	11.23	
2015 CP	spraying	NA	NA	4.23	
2015 CP	seed	Salmanca	3.3 bu/ac	45.00	
2015 CP	inoculant	Cell-tech dry and liquid	labeled	12.00	
2015 CP	starter fertilizer	Nucleus O-Phos 8-24-0	labeled		
2015 CP	herbicide	Sharpen	1.5 oz/ac	28.20	
2015 CP	herbicide	Pendimethalin	1.5 oz/ac		
2015 CP	herbicide	RT 3(Round-up)	22 oz/ac		
2015 CP	harvest	NA	NA	24.10	
2015 CP	spraying	NA	NA	4.23	
2015 CP	herbicide	Honcho (Round-up)	labeled	14.92	
2015 CP	herbicide	Latigo (generic 2,4-D)	labeled		
2015 CP	spraying	NA	NA		4.23
2015 CP	herbicide	Honcho (Round-up)	labeled		14.92
2015 CP	herbicide	Latigo (generic 2,4-D)	labeled		
2015 CP	spraying	NA	NA		4.23
2015 CP	herbicide	Honcho (Round-up)	labeled		14.92
2015 CP	herbicide	Latigo (generic 2,4-D)	labeled		
2015 CP	spraying	NA	NA		4.23
2015 CP	herbicide	Honcho (Round-up)	labeled		14.92
2015 CP	herbicide	Latigo (generic 2,4-D)	labeled		
2016 CP	insurance	after F	$138.31/ac		7.45
2017 CP	insurance	after FP	$89.71/ac	10.54	
2015 CP	fertilizer	dry mix + application	sheet	30.50	30.50
2015 CP	planting	NA	NA	11.23	11.23
2015 CP	starter fertilizer	10-34-0 + mix	3 gal/ac	23.00	23.00
2015 CP	seed	Winterhawk cert/treat	65 lb/ac	15.20	15.20
2015 CP	fertilizer	10-20-0-0.5	10 gal/ac	35.91	35.91
2015 CP	herbicide + aplic	Affinity + Barrage	36.4 + 3.55 oz/ac		
2015 CP	harvest	NA	NA	24.10	24.10
Total Costs				301.61	204.84

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Economics

Rotation	Pea Sales	Wheat Sales	Sales	Expenses	Net
Peas/Wht	36*$5.50 = $198	74*$3.50 = $259	$457	$302	$155
Fallow/Wht	$0	93*$3.50= $325	$325	$205	$120

Peas Advantage over Fallow - Enders 1 year data

		Peas $/bu						
		4	5	6	7	8	9	10
Wheat $/bu	3	-10	26	62	98	134	170	206
	4	-29	7	43	79	115	151	187
	5	-48	-12	24	60	96	132	168
	6	-67	-31	5	41	77	113	149
	7	-86	-50	-14	22	58	94	130
	8	-105	-69	-33	3	39	75	111
	9	-124	-88	-52	-16	20	56	92
	10	-143	-107	-71	-35	1	37	73

Field Peas produced 36 Bu and Wheat produced 74 bu
Fallow Wheat produced 93 bu
Field Peas Wheat Expenses $302
Fallow Wheat Expenses $205

Field Peas as a Potential Fallow Alternative in Northwest Kansas

Lucas Haag, Northwest Area Agronomist, lhaag@ksu.edu
K-State Northwest Research-Extension Center, Colby, Kansas

Spring Field Pea or Dry Yellow Pea

- Annual cool-season grain legume (pulse) crop
- Shallow rooted, 75% of root biomass in the top 2 feet of the profile
- High protein content (21-25%), and 86-87% total digestible nutrients (TDN)
- Works well in livestock rations, no oil so can be dry milled, also an export market for human use

Production Practice Recommendations

- Variety Selection, see K-State and UNL variety performance testing results
- Seeding Rate, minimum 350,000 live seed acre^{-1}, will germinate at soil temps > 40° F
- Seeding depth: 1-3" is acceptable. Seed at least ½" into moisture, never on the dry/wet soil interface
- Inoculation – Pea and lentil inoculant strain, planting into high residual nitrate will reduce fixation
- Weed Control (you have to really dig through the herbicide labels)
    - Field pea is a week competitor with weeds early in the season
    - Preemerge residual herbicide: Spartan, Metribuzin, Dual, Treflan, Command, Sharpen
    - Post options: Raptor, Basagran, Clethodim, Assure II

Water Use and Effect on Subsequent Crops - In a multi-year study at Colby and Tribune, on average:

- Field peas used 3.52" more water than fallow
- Available soil water at wheat planting was 2.55" greater for no-till fallow than after field peas
- Wheat yields after peas averaged 8 bu ac^{-1} less than wheat after fallow in a W-C/S-F rotation
- Previous data at Tribune shows on average that wheat yields decline 3.7 bu ac^{-1} for each inch reduction in available water at planting

Yield Potential

- Our yields are typically most limited by heat stress, especially at flowering time. Substantial reductions in pod set can result. Post-flowering heat and drought stress can result in reduced seeds pod^{-1}

Table 1. Spring pea grain yields at multiple locations in the central and southern High Plains, 2010-2016.

Rotation	Study	Location	Year 2010	2011	2012	2013	2014	2015	2016
Wheat-Corn/Sorghum-Pea			Grain Yield (bu ac^{-1})						
	Fallow Alternative - Haag et al.	Colby	34	8	6	14	-	-	-
		Tribune	27	0	20	-	-	-	-
		Garden City	-	0	22	-	-	-	-
		Bushland, TX	-	0	4	-	-	-	-
	Fallow Alternative - R. Aiken	Colby	35	10	8	13	29	25	
	Field Pea Performance Test	Herndon	-	-	-	-	39	41	31
	Average of top LSD group	Colby	-	-	-	-	28	30	30
		Shallow Water	-	-	-	-	5	-	-
		Garden City	-	-	-	-	0	-	-
		Norcatur	-	-	-	-	-	47	27
		Goodland	-	-	-	-	-	55	-
		Grainfield	-	-	-	-	-	-	28
	Producer Demonstration Plot	Grainfield	-	-	-	-	-	32	-
Wheat-Pea									
	Cover/Grain Intensification - J. Holman	Garden City	33	0	-	-	-	-	-

From Pea Growth Stages – Kent McKay, NCREC – North Dakota State Univ.

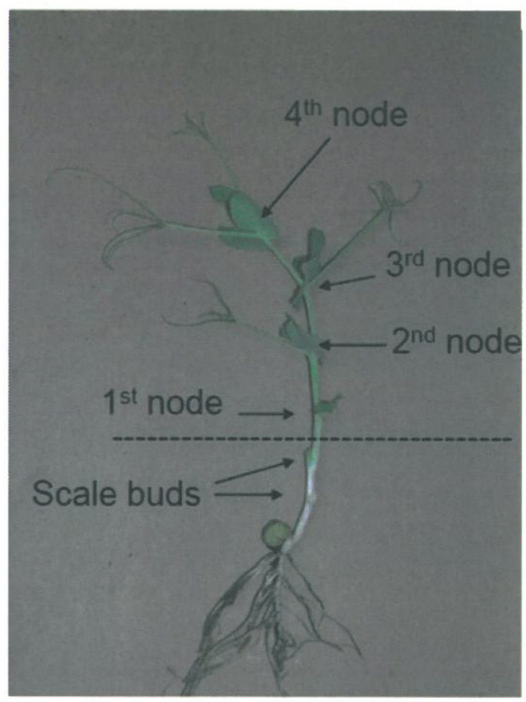
Pea and Lentil Growth Stages

- **1st node/leaf stage:**
  - **Depends on soil temps usually 14 days**
- **2nd node/leaf stage and after: every 4 to 5 days**

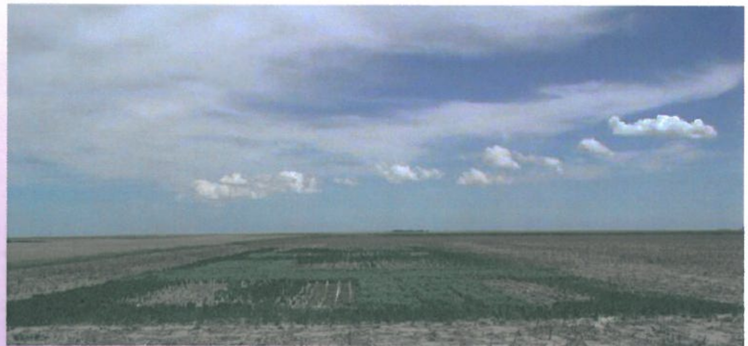
- **Important for frost, herbicide application, rolling, N fixation, etc.**

Key Growth Stages

- Each leaf stage can be identified as a node stage as well
  - Ex. 1st leaf stage = 1st vegetative node stage



Evaluation of Field Pea and Safflower as Fallow Alternatives on the High Plains



Lucas Haag, Northwest Research-Extension Center – Colby
Jeanne Falk, Northwest Research-Extension Center – Colby
Alan Schlegel, Southwest Research-Extension Center – Tribune
John Holman, Southwest Research-Extension Center – Garden City
R. Louis Baumhardt, USDA-ARS CSRL – Bushland, Texas

Locations

- 2010 Pilot Study
  - NWREC-Colby
  - SWREC-Tribune
- 2011-2012 Additions
  - SWREC-Garden City
  - USDA-ARS Bushland

K-STATE Research and Extension
Kansas State University

SWREC-Tribune Field Peas

- DS Admiral Yellow Field Pea
- Planted 16 March 2010 @ 150 lbs ac^{-1}
- Stands were suboptimal
- Four Treatments
  - Terminated 15 May and left as cover crop
  - Terminated 1 June and left as cover crop
  - Allowed to fully mature and left as cover crop
  - Harvested for grain 1 July 2010
  - Tribune peas yielded 1600 lbs ac^{-1} (26.7 bu ac^{-1})
  - Colby peas yielded 2009 lbs ac^{-1} (33.5 bu ac^{-1})
- Winter wheat failed at Tribune and emerged late at Colby (end of February / early March)

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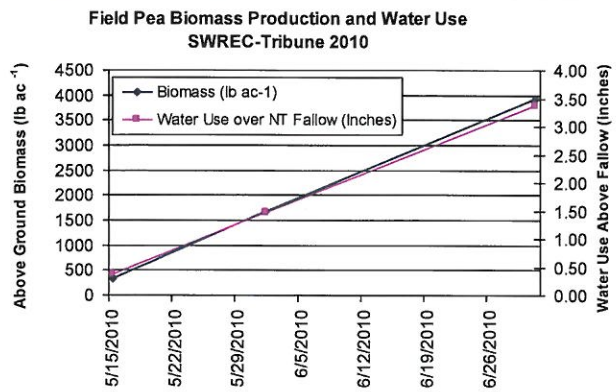
Water Use by Field Peas vs. No-Till Fallow SWREC-Tribune 2010

	Water Use to Date (Inches)		
	15-May Termination	1-Jun Termination	1-Jul Harvest
Peas	2.18	5.42	9.30
Fallow	1.81	3.94	5.92
Fallow Efficiency	23.3%	31.1%	25.9%

Peas effectively used 3.38" of water

K-STATE Research and Extension

Field Pea Biomass Production and Water Use SWREC-Tribune 2010



	15-May	1-Jun	1-Jul
Biomass (lb ac-1)	331	1676	3937
Water Use over NT Fallow (Inches)	0.37	1.48	3.38

Yield-Water Relationship Validation

Table 2. Grain yields and water use as compared to Nielsen 2001 yield-water use model, Colby and Tribune, Kansas, 2010.

Site	Available Soil Water at Planting	In-season Precipiation	Crop Water Use	Grain Yield	Nielsen Predicted Yield from Water Use	% Error
	inches / 4' profile	inches	inches	lbs ac^{-1}	lbs ac^{-1}	
Colby	7.23	8.40	11.39	2009	1913	-5.1%
Tribune	4.04	6.42	9.84	1600	1631	1.9%

Fallow Alternative Impacts on Available Soil Water at Wheat Planting

Table 1. Available soil water at wheat planting as affected by fallow method.
SWREC-Tribune 2010 Preliminary Data

Fallow Method	Available Soil Water at Wheat Planting		
	cm (in)		
NT Fallow	20.4	(8.02)	a
Peas Terminated 6/1	13.9	(5.47)	ab
Peas Harvested for Grain	13.9	(5.47)	ab
Peas Terminated 5/18	13.1	(5.16)	abc
Peas - Green Fallow	12.2	(4.79)	bc
Safflower	6.4	(2.50)	c
	ANOVA P>F		
Source of Variation			
Fallow Method	0.0951		
LSD 0.10	7.3	(2.87)	

†Letters within a column represent differences at LSD (0.10)

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Fallow Alternative Impacts on Available Soil Water at Wheat Planting

Table 2. Available soil water at wheat planting as affected by fallow method.
NWREC-Colby 2010

Fallow Method	Available Soil Water at Wheat Planting		
	cm (in)		
NT Fallow	30.6	(12.05)	a
Peas - Green Fallow	27.1	(10.66)	b
Safflower	18.8	(7.42)	c
	ANOVA P>F		
Source of Variation			
Fallow Method	0.001		
LSD 0.10	3.2	(1.26)	

†Letters within a column represent differences at LSD (0.10)

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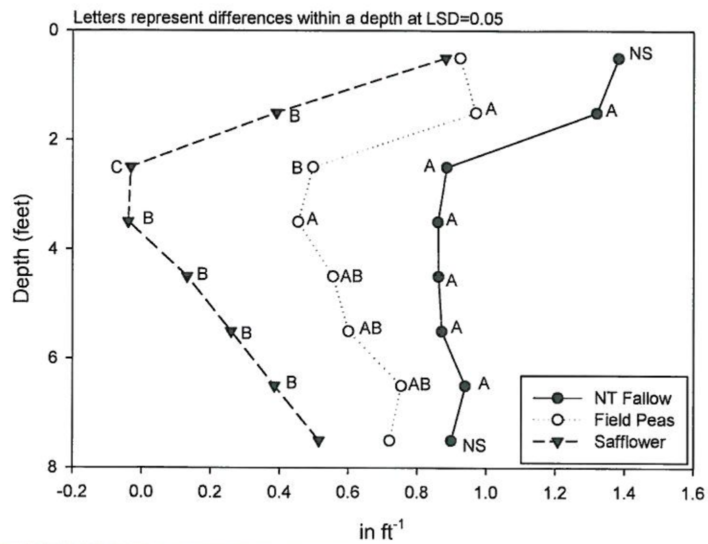
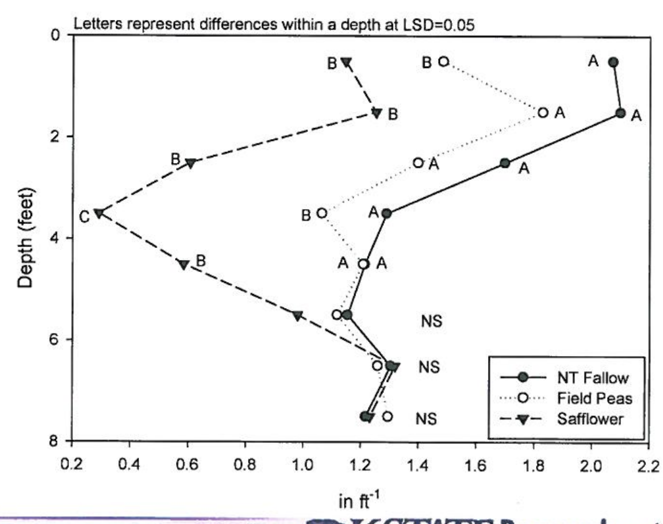
Fallow Alternative Study
SWREC-Tribune 2010
Available Soil Water at Wheat Planting

PRELIMINARY DATA



Fallow Alternative Study
NWREC-Colby 2010
Available Soil Water at Wheat Planting

PRELIMINARY DATA



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Tribune 2011 – Profile Soil Water at Wheat Planting

Table 3. Available soil water at wheat planting as affected by fallow method.
SWREC-Tribune 2011 Preliminary Data

Fallow Method	Available Soil Water at Wheat Planting		
		cm (in)	
Peas Terminated 5/18	17.1	(6.72)	a
NT Fallow	16.7	(6.58)	a
Peas Terminated 6/1	14.4	(5.68)	ab
Peas Harvested for Gı	11.5	(4.53)	b
Peas - Green Fallow	10.2	(4.02)	b
Safflower	4.2	(1.67)	c
	ANOVA P>F		
Source of Variation			
Fallow Met	0.0008		
LSD 0.10	4.2	(1.67)	

† Letters within a column represent differences at LSD (0.10)

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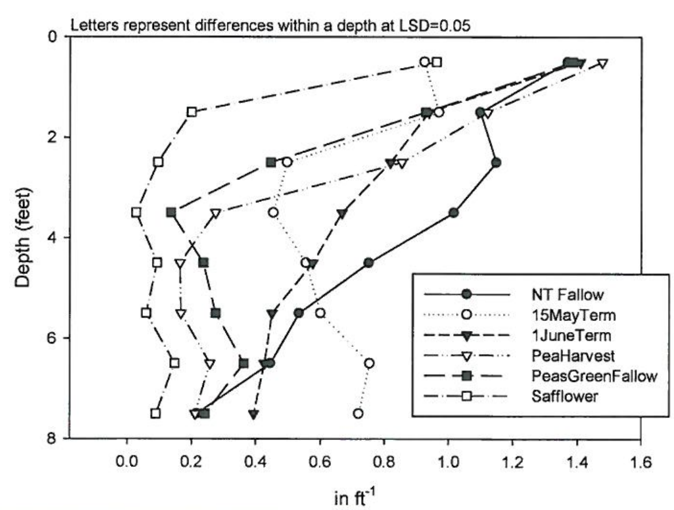
Fallow Alternative Study
SWREC-Tribune 2011
Available Soil Water at Wheat Planting
PRELIMINARY DATA



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2012 Colby Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
NWREC-Colby 2012 Preliminary Data

Fallow Method	Wheat Grain Yield	
	kg/ha (bu/ac)	
Peas Terminated 5/18	(56.59)	a
NT Fallow	(51.22)	ab
Peas Terminated 6/1	(49.19)	ab
Peas Harvested for Grain	(44.50)	bc
Peas - Green Fallow	(40.51)	c
Safflower	(38.44)	c
	ANOVA P>F	
Source of Variation		
Fallow Method	0.0099	
LSD 0.10	(7.96)	

†Letters within a column represent differences at LSD (0.10)

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2012 Garden City Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
SWREC-Garden City 2012 Preliminary Data

Fallow Method	Wheat Grain Yield	
	kg/ha (bu/ac)	
NT Fallow	(30.16)	a
Peas Terminated 5/18	(20.23)	b
Peas Terminated 6/1	(17.57)	bc
Peas - Green Fallow	(16.93)	bc
Midas Peas for Grain	(14.29)	bc
Admiral Peas for Grain	(13.06)	c
Safflower	(4.14)	d
	ANOVA P>F	
Source of Variation		
Fallow Method	0.0003	
LSD 0.10	(6.47)	

†Letters within a column represent differences at LSD (0.10)

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2012 Tribune Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
SWREC-Tribune 2012 Preliminary Data

Fallow Method	Wheat Grain Yield	
	kg/ha (bu/ac)	
NT Fallow	(6.61)	a
Peas Terminated 6/1	(6.22)	a
Peas - Green Fallow	(5.84)	a
Midas Peas for Grain	(5.51)	a
Peas Terminated 5/18	(5.29)	a
Safflower	(0.73)	b
	ANOVA P>F	
Source of Variation		
Fallow Method	0.0092	
LSD 0.10	(3.62)	

†Letters within a column represent differences at LSD (0.10)

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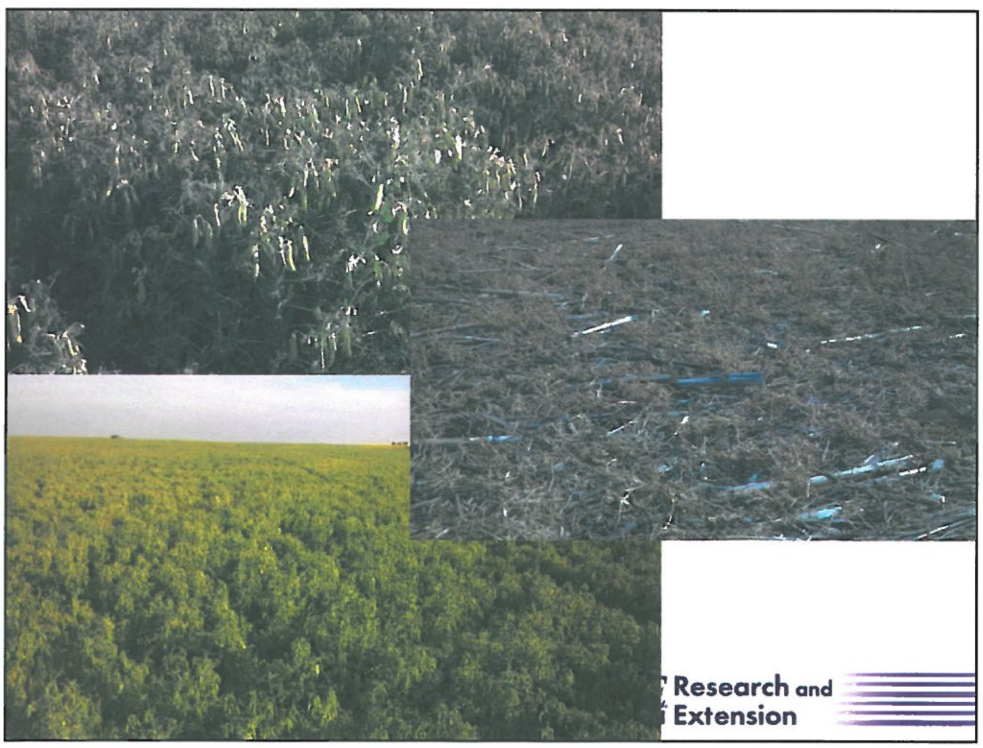

Revisiting Water Use

- Field Pea average water use of 3.38" at Tribune over fallow losses
- Field Pea average water use of 3.66" at Colby over fallow losses
- Field pea stubble resulted in a numerical fallow accumulation advantage of 0.71" over no-till fallow
- Despite the possible fallow accumulation advantage, available soil water at wheat planting was 2.55" greater for no-till fallow over field peas harvested for grain
- The differences in available soil water at wheat planting were most evident at the 2-4' depth.

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Revisiting Water Use

- Long term datasets at Tribune (Stone and Schlegel, 2006) show that each inch of available soil water at planting results in 3.7 bu ac^{-1} of grain yield.
- A potential yield difference of 9.4 bu ac^{-1} would be predicted using the results of this study and previous yield-water relationships. This very closely matches our observations
- **Need to keep a cropping system perspective**

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Questions?

Spring Field Peas at the Colby Branch Experiment Station, 1915

K-STATE Research and Extension

Lucas Haag, Ph.D.
Assistant Professor / Northwest Area Agronomist

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K-STATE Research and Extension

K-State Field Pea Variety Testing

Lucas Haag, Ph.D.
Assistant Professor / Northwest Area Agronomist
Northwest Research-Extension Center, Colby, Kansas

Procedures

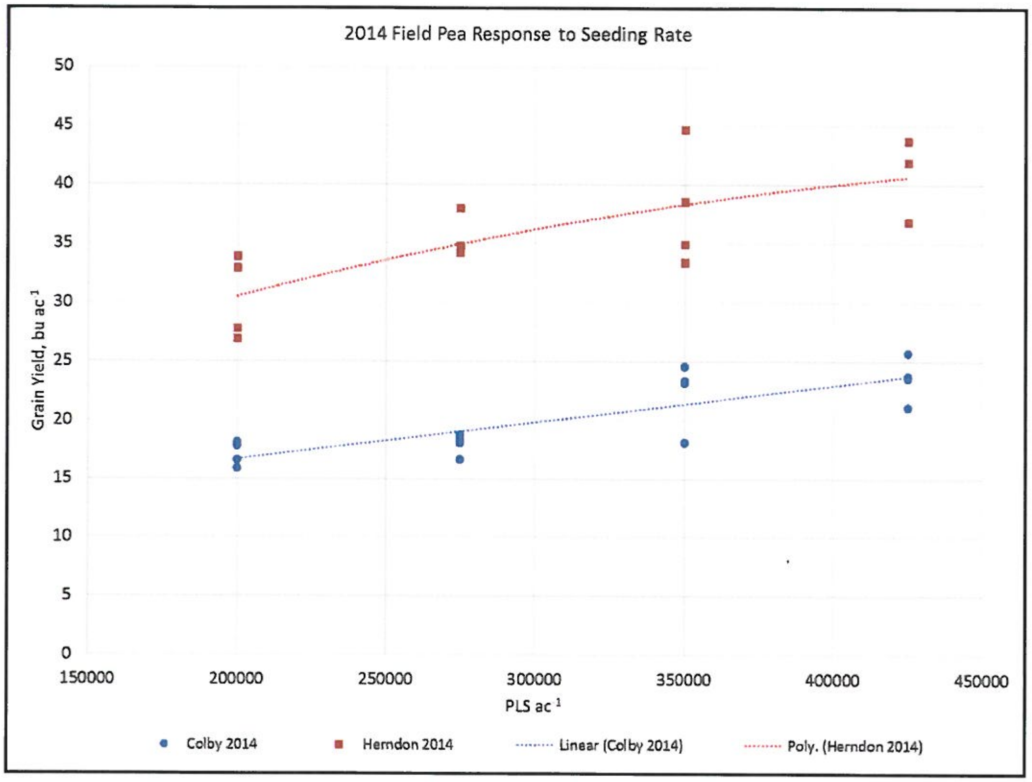
- No-Till into row-crop residue
- Seeded with Great Plains Drill on 7.5”
  Changing
- Targeted drop of 350,000 live seed / acre
  Changing
- Granular inoculant at 1.5x recommended rate
- Plots are 5’ x 40’
- 5 Replications
- Machine harvested

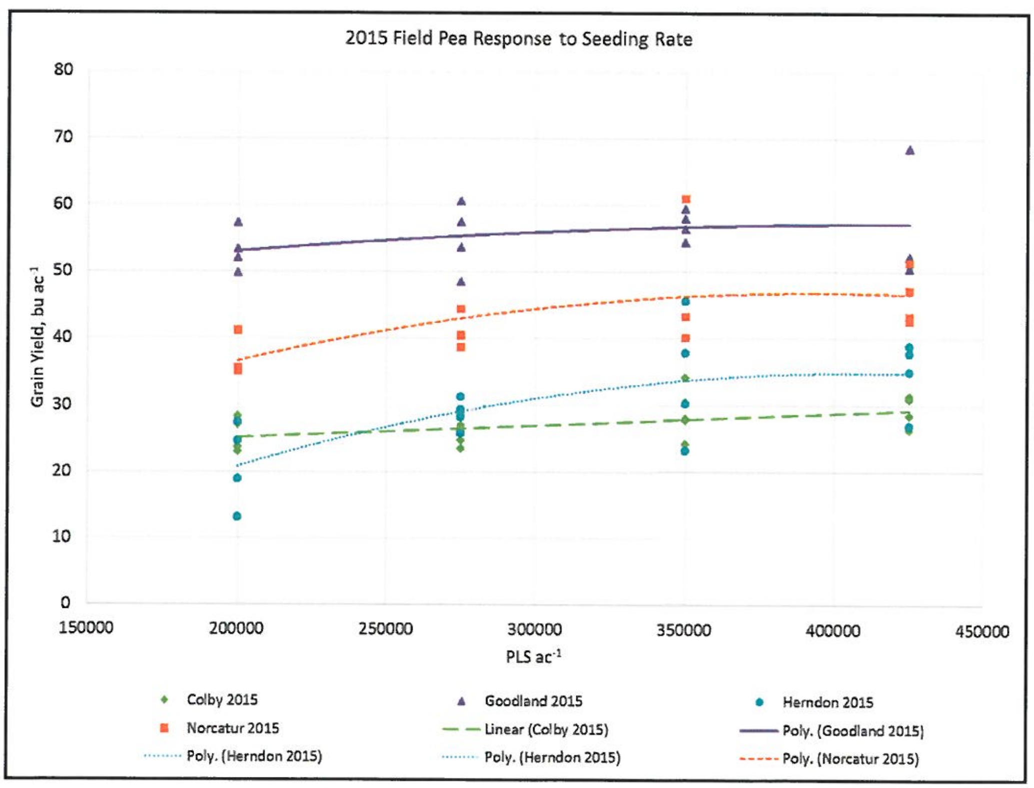
Field Pea VPT Locations

Location	2014		2015		2016	
	Entries	Yield	Entries	Yield	Entries	Yield
RAD	6	47.5	17	30.2	18	27.3
THD	6	25.8	18	23.3	22	27.6
DCD	0	-	9	37.7	18	23.5
GOD	-	-	-	-	14	19.9
SCD	4	4.6	-	-	-	-
SHI	-	-	11	47.1	-	-

Results

- www.northwest.ksu.edu/agronomy


2014 Field Pea Response to Seeding Rate
Grain Yield, bu ac-1
PLS ac-1
Colby 2014
Herndon 2014
Linear (Colby 2014)
Poly. (Herndon 2014)


2015 Field Pea Response to Seeding Rate
Grain Yield, bu ac-1
PLS ac-1
Colby 2015
Goodland 2015
Herndon 2015
Norcatur 2015
Linear (Colby 2015)
Poly. (Goodland 2015)
Poly. (Herndon 2015)
Poly. (Herndon 2015)
Poly. (Norcatur 2015)

Future Work

- Continuing Seeding Rate Studies
- In-Furrow Placement of MAP
- Identification of differences in heat stress tolerance

Supported by Industry – Thank You

- Legume Logic
- Pulse USA
- Great Northern Ag
- Kauffman Seed
- Photosyntech
- Meridian Seeds

Questions

www.northwest.ksu.edu/agronomy

Cover Your Acres Winter Conference

January 17-18th, Oberlin, KS

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K-STATE Research and Extension

Field Pea Workshop - 4, Nov. 2016

Knowledge for Life

FIELD PEA PRODUCTION – PART 1

Field pea variety selection

Dipak Santra - visit online for more information: http://cropwatch.unl.edu/varietytest/othercrops

Nebraska Pea Variety Test - 2016: Lincoln Co.Rainfed (Planting Date: April 8, 2016)

Brand	Variety	Yield rank	Yield (bu/a)	Test weight (lbs/bu)	1000 seeds weight (g)	Seed Protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)	Plant height at harvest (inch)	Emergence %
Pulse USA	Nette 2010	1	46	65	184	25	59	69	10	87	26	73
Meridian	CDC Amarillo	2	45	63	202	26	65	72	7	92	29	73
Legume Logic	Gunner	3	40	62	182	26	61	70	9	88	29	78
Meridian	Jetset	4	38	63	198	26	60	69	8	87	27	70
Great Northern	Bridger	5	37	62	196	26	58	68	10	87	28	70
Arrowseed	Montech 4193	6	37	60	186	25	62	70	9	87	26	78
Great Northern	Navarro	7	37	60	228	26	59	68	9	91	28	63
Pulse USA	Mystique	8	36	60	202	26	62	70	9	88	29	78
Pulse USA	Durwood	9	36	62	203	26	62	70	7	91	30	68
Pulse USA	DS-Admiral	10	35	64	203	26	59	68	9	87	27	70
Legume Logic	Hyline	11	34	60	201	26	62	69	8	88	24	73
Meridian	CDC Saffron	12	33	63	198	26	65	72	7	91	25	55
Pulse USA	Korando	13	31	61	219	27	60	68	8	87	26	75
Great Northern	Salamanca	14	29	61	218	27	62	70	8	89	29	60
Meridian	AAC Carver	15	29	64	213	24	66	72	7	90	29	60
Meridian	AC Earlystar	16	27	61	177	25	60	70	10	86	28	68
Great Northern	Spider	17	26	58	194	27	63	72	9	89	27	60
Pulse USA	Abarth	18	26	58	215	25	62	70	8	89	28	60
Pulse USA	SW Midas	19	22	60	164	25	63	71	8	88	24	65
Average of all entries			**34**	**61**	**199**	**26**	**61**	**70**	**9**	**88**	**27**	**68**
Difference at 5% level			**9**	**3**	**9**	**1**	**1**	**1**	**0**	**1**	**4**	**16**

*DAP = Days After Planting

Nebraska Pea Variety Test - 2016: Perkins Co.Rainfed (Planting: April 8, 2016; Harvest: July 21, 2016)

Brand	Variety	Yield rank	Yield (bu/a)	Test weight (lbs/bu)	1000 seeds weight (g)	Seed Protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)	Plant height at harvest (inch)	Lodging at harvest (%)	Emergence %
Meridian	AAC Carver	1	35	62	211	24	63	81	18	92	13	65	73
Legume Logic	Majestic	2	35	61	201	26	63	82	19	90	13	78	75
Pulse USA	SW Midas	3	34	61	188	25	63	82	19	88	13	88	78
Legume Logic	MP 1907	4	34	62	221	27	63	83	20	93	13	70	83
Pulse USA	DS-Admiral	5	32	60	209	25	62	82	20	89	13	88	80
Pulse USA	Mystique	6	31	59	203	26	62	81	19	95	11	100	85
Pulse USA	Durwood	7	31	61	204	26	62	80	18	96	13	100	85
Meridian	CDC Saffron	8	29	61	205	26	62	83	21	88	11	88	73
Legume Logic	Marquee	9	29	60	170	26	60	82	22	88	10	95	88
Great Northern	Spider	10	28	61	208	27	63	82	19	96	12	95	75
Great Northern	Salamanca	11	27	59	212	26	62	82	20	89	12	98	85
Meridian	Jetset	12	27	61	206	26	62	82	21	91	11	88	83
Legume Logic	Gunner	13	27	61	184	25	61	82	21	91	11	98	80
Arrowseed	Montech 4193	14	27	60	213	25	62	82	20	88	10	100	83
Legume Logic	Hyline	15	26	60	222	25	62	80	19	92	11	98	78
Meridian	AC Earlystar	16	25	60	197	25	62	80	19	92	11	95	85
Great Northern	Navarro	17	24	60	235	26	61	81	20	94	12	90	78
Pulse USA	Korando	18	24	59	231	27	61	82	21	93	12	98	78
Great Northern	Bridger	19	23	60	201	26	61	81	20	88	11	90	88
Pulse USA	Nette 2010	20	22	61	194	25	61	82	21	88	10	83	80
Pulse USA	Abarth	21	21	59	226	25	62	81	19	90	12	88	75
Average of all entries			**28**	**60**	**207**	**26**	**62**	**81**	**19**	**91**	**12**	**90**	**80**
Difference at 5% level			**6**	**2**	**11**	**1**	**1**	**1**	**1**	**5**	**3**	**14**	**11**

*DAP = Days After Planting

Nebraska Pea Variety Test - 2016: Cheynne Co.Rainfed (Planting: April 13, 2016; Harvest: July 22, 2016)

Brand	Variety	Yield rank	Yield (bu/a)	1000 seeds weight (g)	Seed Protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)	Plant height at harvest (inch)	Lodging %
Great Northern	Bridger	1	35	218	23	63	73	10	94	14	60
Pulse USA	Durwood	2	28	223	24	64	72	8	88	17	39
Meridian	Jetset	3	27	232	23	64	71	7	88	16	38
Pulse USA	Mystique	4	26	234	24	65	75	9	86	14	58
Great Northern	Spider	5	25	226	24	65	73	7	86	15	50
Great Northern	Salamanca	6	24	229	23	64	70	6	93	18	43
Meridian	CDC Amarillo	7	24	227	24	68	73	5	84	17	31
Legume Logic	Hyline	8	24	218	23	64	72	8	88	15	40
Pulse USA	Abarth	9	24	246	23	63	72	9	91	17	53
Great Northern	Navarro	10	24	243	23	60	73	13	88	12	78
Meridian	AAC Carver	11	23	224	23	66	74	8	87	17	38
Pulse USA	SW Midas	12	22	213	22	65	74	8	88	16	58
Meridian	AC Earlystar	13	22	212	22	64	73	9	91	13	55
Pulse USA	Nette 2010	14	21	224	23	61	70	9	93	12	53
Pulse USA	Korando	15	20	238	24	61	72	11	94	14	58
Meridian	CDC Saffron	16	18	220	23	65	71	6	91	13	70
Pulse USA	DS-Admiral	17	16	232	23	65	72	7	88	17	16
Average of all entries			**24**	**227**	**23**	**64**	**72**	**8**	**89**	**15**	**49**
Difference at 5% level			**10**	**9**	**1**	**1**	**2**	**2**	**3**	**4**	**30**

*DAP = Days After Planting

Nebraska Pea Variety Test - 2016: Scotts Bluff Co.Rainfed

Planting Date: April 11, 2016 **Harvest Date:** July 21, 2016

Brand	Variety	Yield rank	Yield (bu/a)	1000 seeds weight (g)	Seed Protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)	Plant height at late pod (inch)	Plant height at harvest (inch)	Lodging at harvest (%)	Emergence %
Meridian	CDC Saffron	1	25	230	27	62	69	8	90	17	15	20	90
Meridian	Jetset	2	21	228	25	61	69	8	88	14	13	26	88
Meridian	AC Earlystar	3	19	232	25	61	69	8	88	18	13	51	75
Pulse USA	Nette 2010	4	18	226	26	61	69	8	86	16	12	49	83
Pulse USA	SW Midas	5	17	220	25	60	66	6	84	16	11	45	80
Pulse USA	Korando	6	14	220	26	60	70	10	86	18	12	44	83
Great Northern	Navarro	7	13	256	26	59	67	8	85	15	13	40	75
Pulse USA	Abarth	8	12	233	26	60	68	8	86	16	12	35	78
Great Northern	Spider	9	11	230	26	60	69	9	84	17	12	46	80
Pulse USA	Durwood	10	11	218	26	61	66	5	84	15	12	35	75
Pulse USA	Mystique	11	11	225	26	57	64	7	83	14	11	36	73
Legume Logic	Hyline	12	10	227	25	61	69	8	86	15	13	49	83
Great Northern	Bridger	13	7	203	25	59	68	9	83	14	12	53	73
Meridian	CDC Amarillo	14	7	199	25	60	69	10	84	17	10	78	78
Pulse USA	DS-Admiral	15	5	238	25	60	67	7	83	15	12	73	78
Meridian	AAC Carver	16	5	224	26	61	67	6	84	15	6	90	65
Average of all entries			13	**223**	**26**	**60**	**68**	8	**85**	**15**	**12**	**50**	**77**
Difference at 5% level			9	**15**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**24**	**13**

*DAP = Days After Planting

Nebraska Pea Variety Test - 2016: Scotts Bluff Co.Irrigated

Planting Date: April 11, 2016 **Harvest Date:** July 21, 2016

Brand	Variety	Yield rank	Yield (bu/a)	1000 seeds weight (g)	Seed protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)	Plant height at late pod (inch)	Plant height at harvest (inch)	Lodging at harvest (%)	Emergence %
Pulse USA	Nette 2010	1	58	244	25	61	69	8	90	22	15	56	78
Meridian	Jetset	2	52	240	27	61	69	8	89	19	17	23	80
Pulse USA	DS-Admiral	3	50	238	26	61	69	8	90	19	16	43	68
Pulse USA	Mystique	4	48	238	25	61	74	13	92	22	18	39	75
Pulse USA	Durwood	5	45	234	27	61	73	12	93	20	18	33	73
Meridian	CDC Amarillo	6	45	224	25	62	72	10	93	21	20	18	85
Meridian	CDC Saffron	7	42	231	26	63	70	8	91	18	13	61	70
Pulse USA	SW Midas	8	40	210	25	61	71	10	91	18	14	64	65
Legume Logic	Hyline	9	40	242	23	62	72	11	92	19	13	76	68
Pulse USA	Korando	10	40	248	27	59	69	10	90	17	14	45	68
Great Northern	Salamanca	11	39	245	26	62	72	10	91	20	17	45	78
Pulse USA	Abarth	12	38	249	26	62	69	8	90	18	16	44	73
Great Northern	Navarro	13	38	256	26	58	71	13	92	19	17	33	83
Great Northern	Spider	14	38	240	26	62	74	13	93	20	15	53	85
Meridian	AAC Carver	15	35	234	24	62	70	8	91	23	16	33	65
Meridian	AC Earlystar	16	33	222	25	61	74	13	90	22	18	39	78
Great Northern	Bridger	17	30	226	26	60	69	9	90	18	14	76	73
Average of all entries			**42**	**236**	**26**	**61**	**71**	10	**91**	**20**	**16**	**46**	**74**
Difference at 5% level			**17**	**16**	**1**	**2**	**3**	**1**	**2**	**3**	**3**	**26**	**12**

*DAP = Days After Planting

2016 Pea Variety Evaluation in western Nebraska: (Cheyenne Co. - Perkins Co. - Lincoln Co.)

Brand	Variety	Yield rank	Yield (bu/a)	1000 seeds weight (g)	Seed Protein (%)	Flowering start (DAP*)	Flowering end (DAP)	Flowering period (days)	Physiological maturity (DAP)
Great Northern	Bridger	1	32	205	25	61	74	13	90
Pulse USA	Durwood	2	32	210	25	63	74	11	92
Pulse USA	Mystique	3	31	213	25	63	75	12	90
Meridian	Jetset	4	31	212	25	62	74	12	89
Pulse USA	Nette 2010	5	30	201	24	60	74	13	89
Meridian	AAC Carver	6	29	216	24	65	76	11	90
Great Northern	Navarro	7	28	235	25	60	74	14	91
Legume Logic	Hyline	8	28	214	25	63	74	12	89
Pulse USA	DS-Admiral	9	28	215	25	62	74	12	88
Great Northern	Salamanca	10	27	220	25	63	74	11	90
Meridian	CDC Saffron	11	27	208	25	64	75	11	90
Pulse USA	SW Midas	12	26	188	24	64	76	12	88
Great Northern	Spider	13	26	209	26	64	76	12	90
Pulse USA	Korando	14	25	229	26	61	74	13	91
Meridian	AC Earlystar	15	25	195	24	62	74	13	90
Pulse USA	Abarth	16	24	229	24	62	74	12	90
Average of all entries			**28**	**212**	**25**	**62**	**74**	**12**	**90**
Difference at 5% level			**9**	**11**	**1**	**2**	**2**	**2**	**5**

*DAP=Days After Flowering

Pea Variety Evation Across Years (2014-'16) at the HPAL in Cheyenne Co (Rainfed)

Brand	Variety	Yield rank	Yield (bu/a)	*Bushel weight (lbs/bu)	1000 seed weight (g)	Protein (%)	Flowering (days after planting)
Great Northern Ag.	Bridger	1	34	60	241	24	62
Great Northern Ag.	Spider	2	32	59	254	25	64
Great Northern Ag.	Salamanca	3	31	58	249	25	63
Pulse USA	Mystique	4	30	59	250	24	63
Meridian Seeds	AC Earlystar	5	29	59	230	23	63
Pulse USA	Hyline	6	28	60	246	24	63
Meridian Seeds	Jetset	7	28	59	244	24	63
Pulse USA	SW Midas	8	27	58	226	23	64
Pulse USA	Nette 2010	9	27	60	235	24	61
Great Northern Ag.	Navarro	10	26	60	235	24	61
Pulse USA	DS Admiral	11	26	59	241	24	63
Pulse USA	Abarth	12	25	59	258	23	62
Average of all entries			**28**	**59**	**242**	**24**	**63**
Difference at 5% level			**7**	**1**	**23**	**1**	**2**

Pea Variety Testing at North Platte (Lincoln Co.) and Grant (Perkins Co.): Averages of 2015 and 2016

Brand	Variety	Yield Rank	Yield (bu/a)	Bushel weight (lbs/bu)	1000 seeds weight (g)	Flowering (DAP*)	Plant height at harvest (inches)
Pulse USA	Durwood	1	32	63	212	68	26
Pulse USA	Nette 2010	2	32	64	200	68	19
Meridian Seed	ACC Carver	3	32	64	210	70	23
Meridian Seed	Jetset	4	31	63	207	68	21
Pulse USA	Mystique	5	31	62	208	69	23
Pulse USA	DS Admiral	6	30	63	214	69	19
Meridian Seed	CDC Saffron	7	30	63	215	70	19
Great Northern Ag.	Salamanca	8	30	63	225	69	24
Arrowseed	Montech 4193	9	30	62	212	70	20
Great Northern Ag.	Bridger	10	29	63	208	67	23
Great Northern Ag.	Navarro	11	29	62	239	67	20
Legume Logic	Hyline	12	28	63	217	69	19
Pulse USA	Midas-SW	13	27	62	197	69	18
Great Northern Ag.	Spider	14	27	62	215	70	20
Pulse USA	Abarth	15	26	61	231	68	22
Meridian Seed	AC Earlystar	16	26	63	199	70	22
Average of all entries			**29**	**63**	**213**	**69**	**21**
Difference at 5% level			**2**	**2**	**12**	**2**	**3**

FIELD PEA PRODUCTION – PART 1

Seeding rates, seeding depth, and inoculant

Strahinja Stepanovic, Rodrigo Werle

Table 1. Recommended field pea seeding practices for various regions (inoculant recommended for all regions)

Region	Seeding depth (inch)	Seeding date	Seeding rate (lbs/ac)*	Source
Manitoba, CA	1 - 2	Before May 21	150-171	Manitoba Agriculture (2016)
Alberta, CA	1 - 2	Before May 15	161-193	Alberta Pulse Growers (2016)
Saskatchewan, CA	1– 3	Mid-April to Mid-May	161-184	Saskatchewan Pulse Growers (2016)
North Dakota, USA	1 - 3	early-April to mid-May	161-184	Schatz and Enders (2009)
Montana, USA	1 - 3	late-March to early-May	184-229	McVay et al. (2016)
South Dakota, USA	1.5 - 3	mid-April	184	Beck et al. (2015)
Washington/Idaho, USA	1.5 - 3	March 25- May 10	191-231	Muehlbauer et al. (1997)
Wisconsin/Minnesota, USA	1 - 3	mid-March to mid-April	204	Oelke et al. (1991)

*Seeding rates target final plant population ranging from 300,000 to 500,000 plants/ac

1. Seeding rate study

Results. Yield response to plant population was linear at low densities (0 to 150,000 plants/ac), then continued to increase with decreasing rate (150,000-200,000 plants/ac), beginning to plateau at about 200,000 plants/ac, and reaching its maximum at approximately 310,000 plants/ac (see figure below). Due to low germination rate (58%), yield response at higher populations was not obtained in 2015. Yield in 2015 was higher (33 bu/ac yield goal) than in 2016 (25-26 bu/ac yield goal) regardless of population density. Although yield response at populations higher than 310,000 plants/ac was seldom observed, there is an indication that for yield goals higher than 30 bu/ac increasing seeding rate may be justified.

Assuming that:

- Field peas variety has 2100 seeds/lb, test weight of 60 lb/bu at 12% moisture, and 90% germination
- Hail event or some other factor that may reduce stand count after emergence does not occur
- Price to purchase certified field pea seed = $15/bu
- Price of field peas on the market = $7/bu
- Data from multi years/locationson yet needs to be collected before making final recommendations on field peas seeding rates

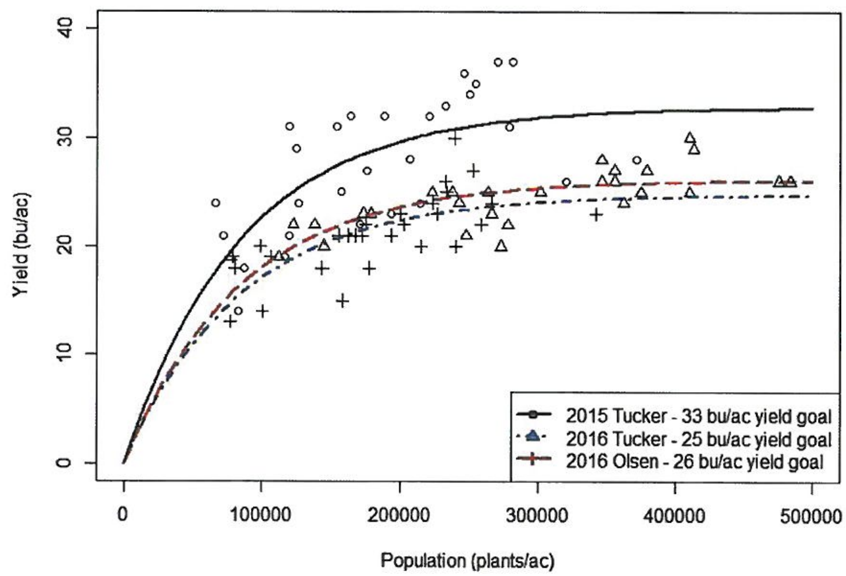
According to the results of our three-year/location study and using the aforementioned assumptions, **economically optimal population** (i.e. maximum profit) for field peas is 220,000 plants/ac, which coresponds to 116 lb of seed/ac seeding rate. About $0.19/ac penalty may occur for each additional pound of seed planted over this EOP. Curent practice of many frarmers in Central Great Plains is 180 to 200 lbs/ac; therefore, EOP may save them up to $16/ac.

Economically optimal populations (EOP) is defined as the population (in plants/ac) that maximizes profit made on the investment, which in this case is the seed cost. Thus, planting higher populations to maximize yield potential is not always the best economic strategy due to the asymptotic nature of yield response to planting density.

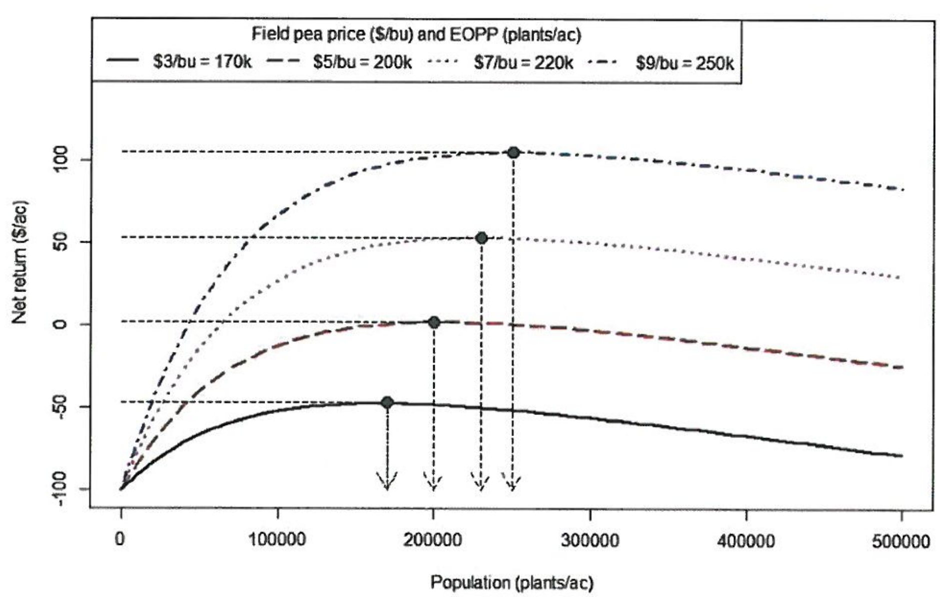
SEEDING RATE RECOMMENDATION

Although this study shows the potential for reduction in field pea population without lowering profits, these results are yet to be confirmed in additional production years and/or locations and should be considered cautiously until further research is completed and results validated. Current recommendations for field peas seeding rates ranges from 180 to 200 lb/ac. UNL has been awarded a large SARE grant for additional field pea research (2017-2020)

Field peas response to population density



Economically Optimal Plant Population (EOPP)



2. Seeding depth and rhizobia inoculant study

Seeding depth study. Feld pea is a large seeded crop that generally requires deeper seeding than smaller seeded cereals for proper soil-seed contact (Table 1). Large seeds can emerge from greater depths because they have larger amounts or stored energy. However, to ensure proper germination and emergence seeds should be placed in soil with adequate moisture. Dry top soil moisture at planting is the main reason why slightly deeper seeding is recommended for dryer and warmer climate of Pacific North West (1.5 inches) compared to Canada and Norther Great Plains (1 inch; Table 1). Although field pea can tolerate deeper seeding, research from Canada showed that seeding >2.5 inches deep can cause significant reduction in stand and up to 8.5% yield loss compared to shallower seeding (1-2.5 inches).

Rhizobia inoculant study. The need to re-introduce the Rhizobia with each field pea crop depends on the ability of the bacteria to survive in the soil over a given time period. Research conducted in Mediterranean soils showed that population size of field pea rhizobia is likely to be under the optimal nodulation thresholds (<100/g of soil) if soil pH <6.6,when summers are hot and dry, and a plant host has been absent for > 5 years. On the American continent, there are few documented studies that can provide economic justification for re-introduction of field pea rhizobia at each planting, especially at sites that have recent history of field pea production. Research needs to be done to verify these claims.

Study outline. Preliminary seeding depth and rhizobia inoculant studies were conducted in 2015 (site 1). In 2016, we tested the potential for carryover of rhizobia inoculant in soil by selecting site 2 that had history of field pea crop grown two years ago (2014), and site three that had field pea crop grown 3 years ago (2013).

Table 2. Yield results from seeding depth and inoculant study

Study	Year	Location	Treatment	Yield (bu/ac)
Seeding depth (inches)	2015	Site 1	1.5	29
			2.5	26
	2016	Site 2	1	10
			2	13
			3	12
	2016	Site 3	1	22
			2	23
			3	25
Rhizobia Inoculant	2015	Site 1	none	25
			liquid	28
			granular	27
	2016	Site 2	none	10
			liquid	13
	2016	Site 3	none	20
			liquid	23

RECOMMENDATIONS - SEEDING DEPTH AND INOCULANT

We observed no significant difference in yield between 3 seeding depths. Plant in moisture zone, 1 to 3 inches deep, and ensure good seed-to-soil contact. Although yield differences between inoculated and non-inoculated field pea were not observed, non-inoculated peas did not produce nodules and will have to rely solely on residual soil nitrogen rather than biological fixation. Therefore, inoculant is recommended.

Field Pea
Weed Response to Selected Herbicides

Site of Action		Broadleaves: Kochia	Lambsquarters	Lanceleaf Sage	Marestail	Redroot Pigweed	Prickly Lettuce	Russian-thistle	Wild Buckwheat	Grasses: Barnyardgrass	Crabgrass	Downy Brome[1]	Fall Panicum	Millet	Crop Safety
	PRE														
14 + 15	BroadAxe XC / SpartanElite	9	9	4	6	9	6	9	6	9	8	9	9	8	2
15	Dual II Magnum	5	7	6	2	8	5	4	3	8	8	9	9	7	2
3	Prowl H2O	7	7	6	6	7	7	8	5	8	7	8	8	8	2
3	Treflan (PPI)	7	6	3	5	6	5	7	4	8	8	8	8	8	1
14	Spartan Charge	9	8	4	7	8	7	8	6	6	6	6	6	6	2
14 + 2	Optill	8	8	8	8	6	8	8	8	6	2	6	6	6	2
14	Sharpen	8	8	7	8	5	7	8	7	2	4	3	2	2	2
14	Spartan	9	8	4	6	7	6	8	5	6	6	6	6	6	2
	POST														
1	Assure II	1	1	1	1	1	1	1	1	8	8	7	8	8	1
6	Basagran 5L	7	7	5	4	5	7	4	6	1	1	1	1	1	2
1	Poast	1	1	1	1	1	1	1	1	6	9	9	9	9	1
2	Pursuit	7	4	4	5	8	7	7	7	5	6	7	1	8	3
2 + 6	Pursuit + Basagran 5L	8	7	6	6	8	8	7	6	5	5	7	5	6	2
2 + 6	Raptor + Basagran 5L	8	8	6	6	9	8	7	7	5	7	6	1	2	2
1	Select Max	1	1	1	1	1	1	1	1	9	9	9	9	9	1
2 + 6	Varisto	8	8	6	6	9	8	7	7	5	7	6	1	2	2

[1]Field pea PRE herbicides used to control downy brome must be tank mixed with glyphosate or follow a glyphosate burndown application to obtain these levels of control.

Field Pea *(continued)*

Herbicide	Rate Per Acre	Application Time	Remarks
Fall Applied			
BroadAxe XC / SpartanElite	19.0-32.0 oz	Fall	Cost: $20.75-$35.00.
Optill	1.5 oz	Fall	Can be tank mixed with other herbicides such as glyphosate for burndown. Cost: $12.00.
Spartan	3.5-8.0 oz	Fall	Application rate depends on soil type and organic matter. Cost: $16.50-$37.50.
Spartan Charge	4.0-10.0 oz	Fall	Use with other herbicides and COC for burndown purposes. Application rate depends on soil type and organic matter. Cost: $13.75-$34.50.
Valor SX	2.0-3.0 oz	Fall	Use only with appropriate tank mix partner such as 2,4-D, dicamba, or glyphosate. Cost: $15.50-$23.00.
Burndown and Preemergence			
BroadAxe XC / SpartanElite	19.0-32.0 oz	Preplant burndown, EPP, or PRE	Rate depends on soil texture, pH, and organic matter. DO NOT use on coarse textured soils with organic matter <1.5%. Cost: $20.75-$35.00.
Spartan Charge	3.0-8.0 oz	Preplant burndown, EPP, or PRE	Apply with COC, AMS, and glyphosate for burndown purposes. Application rate depends on soil type and organic matter. Cost: $10.25-$27.50.
Optill	1.5 oz	EPP, PPI, or PRE	Can be tank mixed with other herbicides such as glyphosate for burndown. Cost: $12.00.
Sharpen	1.0 oz	EPP	If needed, sequential applications can be made at least 30 days apart (no more than 4 ozs/A/plant season). Sharpen can be tank mixed with other Group 14 herbicides. Cost: $7.00.
Prowl H2O	1.5-3.2 pt	Preplant burndown	Rate based on soil texture and organic matter. Tank mix with or apply a postemergence herbicide following application. Irrigation or rainfall is required to infiltrate the herbicide into the upper soil surface. Cost: $9.75-$20.75.
Dual II Magnum	1.0-1.67 pt	PPI, or PRE	Rate based on soil texture and organic matter. Cost: $15.00-$25.00.
Pursuit	3.0 oz	Preplant, PPI, and PRE	Must be incorporated into the soil for best results. Postemergence application require use of an adjuvant and nitrogen fertilizer. Can be tank mixed with grass herbicides. Cost: $11.50.
Postemergence			
Assure II	5.0-10.0 oz	Grasses less than 4" tall	Apply with COC. Cost: $4.00-$8.25.
Basagran 5L	1.0-2.0 pt	After 3 pairs of leaves or 4 nodes are present on peas	Best performance when daily temperatures exceed 75 degrees. Apply with UAN or AMS. May tank mix with MCPA, Pursuit, or Raptor. 30 day PHI. Cost: $10.00-$20.00.
Poast	1.0-2.0 pt	Grasses less than 4" tall	Apply with 2.5 pounds AMS or 4 to 8 pints of UAN. Maximum seasonal application rate is 4 pints per acre. PHI is 30 days. Cost: $12.00-$28.00.
Pursuit	3 oz	Peas have at least one trifoliate leaf but before 5 nodes and flowering	Apply with NIS at 2 pints/acre. Cost: $11.50.
Pursuit + Basagran 5L	3 oz + 0.8 pt	After 3 trifoliate leaves are present until 5 nodes are on the peas	Apply with 1.25 at 2.5 gallons UAN or 12 to 15 pounds per 100 gallons AMS. 30 day PHI. Cost: $11.50.
Raptor + Basagran 5L	4.0 oz + 1.0 pt	After 3 pairs of leaves are present and prior to bloom	Apply with COC at 1-2% v/v. Cost: $29.00.
Select Max	9.0-16.0 oz	Before bloom	Apply with NIS at 0.25% v/v. PHI is 21 days. Cost: $7.75-$13-75.
Varisto	16.0-21.0 oz	After 3 pairs of leaves are present and prior to bloom	Apply with COC at 1-2% v/v. PHII is 30 days. Cost: $20.75-$27.00.
Harvest Aid			
Gramoxone	1.2 - 2.0 pt	Apply when at least 80% of pods are yellowing	Apply using a minimum carrier of 20 GPA for ground or 5 GPA for air. Add NIS at 1qt/100 gal. Do not graze or harvest treated fields for 7 days after spraying.

IRRIGATED FORAGE PEA STUDY IN 2003

R. F. Meyer
Colorado State University Cooperative Extension

Irrigated forage production within the Colorado High Plains has been increasing. Producers are looking for flexible forage production options that will fit into High Plains cropping patters. In addition, irrigation wells within the High Plains region have been losing capacity, straining to meet evapotranspiration demands of some summer crops.

During the 2003 season, forage peas were planted in combination with triticale and oats. Three pea varieties (Arvika, Forager, Salute) were investigated along with oats (126, 114) and a triticale variety (Lazer). Data on yield, protein, ADF, TDN, calcium, phosphorous, and nitrate-Nitrogen were used to compare the different varieties. Small plots, 5 feet wide by 33 feet long were used for the study. Harvest area was 3 feet wide by 30 feet long. Plots were planted on 3/25/03 and harvested on 6/16/03. No herbicide was applied. No fertilizer was applied. Irrigation method was center pivot and 4 inches of water was applied. The plot was located near Burlington, Colorado (elevation 4220 feet above sea level).

Results: Yield on a dry matter basis from Lazer triticale, Arvika peas, Arvika/Lazer, Forager peas/Lazer, Salute peas, Salute/Lazer, Forager/Oats(126), oats(114) were 3.97, 1.56, 4, 3.67, 2.3, 2.7, 3, and 3.2 tons per acre, respectively. Lazer triticale increased yields when added to Arvika and Forager, but did not increase yield when added to Salute. Oats (126) added to Forager did not yield as well as the Forager/Lazer mix. Lazer, Arvika/Lazer, Forager/Lazer, and Oats (114) yielded highest. Arvika and Salute by themselves yielded lowest.

The highest protein was found in Arvika, and followed by Salute, Forager/Oat, and Oat (114) treatments. The addition of forage peas to Lazer triticale increased protein levels. Further, the Oat-only treatments appeared to have the potential to increase protein levels similar to levels expressed by the strait pea treatments.

The addition of forage peas to Lazer triticale did not affect ADF levels, however, increased TDN, Calcium, Phosphorous, or Nitrate-nitrogen levels were observed. Oats, however, recorded higher levels than did triticale of protein, TDN, and nitrate-nitrogen, but recorded lower levels of ADF. Calcium levels were the same between oats and triticale.

TDN levels were highest from Oats (114), Arvika, and Salute and lowest from treatments that contained Lazer triticale.

Calcium levels were highest form Arvika and Salute by themselves.

Irrigated forage pea study in 2003

Treatment	*Yield T/A DM*	*Protein*	*ADF*	*TDN*	*Calcium*	*Phos*	*N03N PPM*
Lazer Triticale	3.97a	12.6b	45.4a	51.7e	0.39b	0.33c	1488cd
Arvika Peas	1.56e	19.3a	39.9d	57.9b	0.99a	.048a	387e
Arvika/Lazer	4a	13.5b	43.7abc	53.6cde	0.41b	0.35bc	1147d
Forager/Lazer	3.67abc	14.4b	42bcd	55.5bcd	0.42b	0.33c	1315cd
Salute Peas	2.3de	18.1a	39.7d	58.2b	1.03a	0.38abc	421e
Salute/Lazer	2.7cd	16ab	44.8ab	52.4de	0.52b	0.37abc	1698c
Forager/Oats (126)	6bcd	18.1a	40.9cd	56.8bc	0.63b	0.45ab	4087a
Oats (114)	3.2abcd	19.5a	36e	62.2a	0.59b	0.39abc	2400b

Numbers followed by the same letters are not statistically different.

Winter pea performance in Wyoming

University of Wyoming

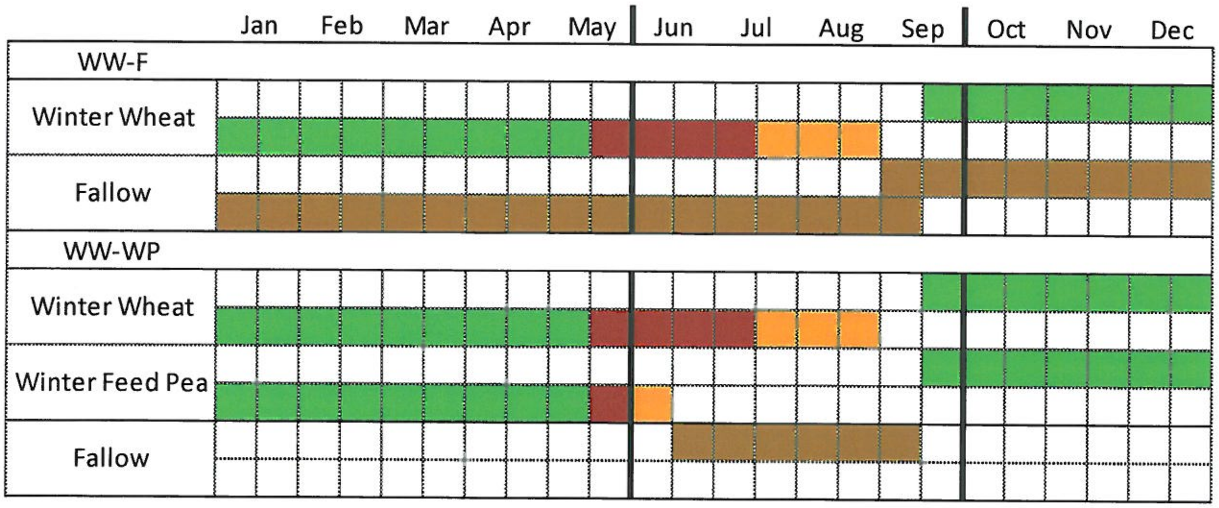
Presenter: Dr. Carrie Eberle email: carrie.eberle@uwyo.edu

Contributors: Dr. Robin Groose, Dr. Jim Krall, Dr. Anowar Islam, Dr. Azize Homer

UNIVERSITY OF WYOMING EXTENSION

The traditional winter wheat-fallow system has helped to assure successful establishment of wheat in alternate years in a semi-arid environment (Figure 1). However, approximately 50% of native soil organic matter has been lost on the Central Great Plains (CGP) since the inception of this rotation. Also, only 20-30% of precipitation during the long 14-month fallow is conserved. A winter wheat—winter feed pea system might more efficiently use water, introduce a legume into the rotation, build soil organic matter, and provide a sufficient short true fallow prior to wheat planting (Figure 1). Finally, many eastern Wyoming agriculture producers are both wheat growers and livestock producers but, generally, the two aspects of their operations are not integrated. Perhaps a locally adapted legume, such as winter feed pea, might sustainably and synergistically integrate crop and livestock production in Wyoming.

Figure 1: Approximate crop season in the Central Great Plans for winter wheat-fallow (WW-F), and winter wheat-winter feed pea (WW-WP). Green = vegitative growth, Red = flowering, Gold = harvest, Brown = fallow



In 2000, Dr. Robin Groose initiated a breeding program at UW to develop locally adapted new winter pea cultivars with a high level of tolerance to cold stress and optimum forage and seed yield. The result of the program was identification of an elite winter pea lines, Wyo#11 (WyoWinter). Wyo#11 was evaluated over multiple locations under rain fed and irrigated conditions with the three most available U.S. winter pea cultivars "Common", 'Specter', and 'Windham' for both forage and seed yield (Table 1).

Under both dryland and irrigated production Wyo#11 showed increase forage production and increased seed production over the common lines (Table 1). Currently, Wyo#11 seed is being considered for release. Agronomic rotation research is ongoing to establish best management practices for establishing winter feed pea in the winter wheat rotation.

Table 1: Mean yield of winter pea in pound per acre grown for early season forage or to maturity for seed on dryland or under irrigation.[1]

line	Dryland Forage	Irrigated Forage	Dryland Seed	Irrigated Seed
Wyo#11	619 a	2444 c	851 a	2006 b
Common	473 d	1915 f	632 bc	1663 d
Specter	340 g	2014 e	557 c	1536 e
Windam	336 g	1570 i	696 abc	1446 f

[1] This table was modified from the 2013 WAES Field Days Bulletin article by Homer et al.

Within column, means followed by the same letter not significanlty different at $\alpha = 0.05$

Characteristics of Wyo#11

1. Winter feed pea, capable of seed production when spring planted
2. Indeterminate growth habit
3. Purple flowers
4. 1,000 seed weight is 110 grams
5. Seedlings emerge with multiple shoots
6. 66-68 days to flower under irrigation
7. Cutting for forage should be done at full flower, mid to late June.

References

Wyoming production of locally bred winter pea to integrate crop and livestock production (2015). Islam A., Anderson T., Bowman D., Geortz G., Nachtman J., Groose R. Field Days Bulletin WAES 2015.

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Breeding Winter-Hardy Feed Pea for Wyoming. (2013). Homer A., Krall J.M., Nachtman J.J., Groose R.W. Field Days Bulletin WAES 2013.

Cooking Yellow Split Peas

Nancy Frecks

Basic Recipe

- No need to soak before cooking
- 3 cups water - 1 cup split peas
- Cook one hour (simmer gently)
- Yield 2 cups cooked split peas
- Do not add salt or acid until the end of cooking
- Add 1 teaspoon fat to prevent foaming

Casserole

- INGREDIENTS 2 cups lentils or split peas
- 1 16-ounce can tomato sauce
- 1 16-ounce can stewed tomatoes
- 2 cups grated cheddar cheese
- 2 green peppers, chopped
- 2 medium onions, chopped
- 2 tablespoons oil
- ½ teaspoon basil
- ½ teaspoon thyme
- ¼ teaspoon pepper

INSTRUCTIONS:

- Sort, rinse and drain lentils or peas
- Combine with 6 cups water in a large pot
- Simmer 30 minutes or until tender. Drain.
- Cook onions and green pepper in oil until soft.
- Reserve ¼ cup cheese.
- Mix together all ingredients and place in a baking dish.
- Sprinkle reserved cheese on top.
- Bake at 350°F for 1 hour. Serves 6.

Crispy Split Peas

INGREDIENTS:

- ½ cup split peas, soaked for 4 hours in water
- ½ tbsp olive oil
- ½ tsp salt
- 1 tsp any herbs/spices desired

INSTRUCTIONS:

- After soaking the split peas, drain and pat dry
- Over medium-high heat, coat a large skillet with oil
- Add the split peas along with the salt and desired seasoning and stir frequently until golden in color and crunchy in texture (7-10 minutes)
- Remove from pan and serve or store in an air tight container

Sources

University of Alaska Fairbanks Cooperative Extension Service. Cooking Dried Beans, Peas and Lentils. www.uaf.edu/files/ces/publications-db/catalog/hec/FNH-00360.pdf

USA Pulses. www.cookingwithpulses.org

UNL Food. www.food.unl.edu

Gluten-free Flour Blend

Ben Dutton

Gluten-free flour blend using pre-cooked pea flour that can be substituted for all-purpose flour in most recipes.

INGREDIENTS:

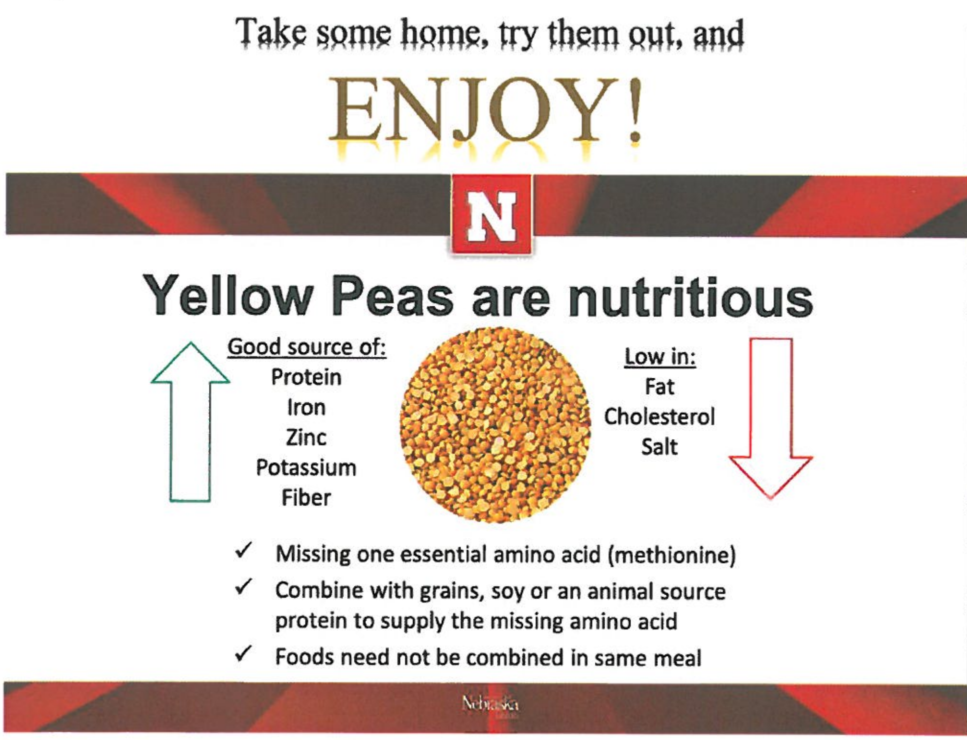
- 1 1/4 cups (240 g) pre-cooked yellow pea flour
- 1/2 cup (96 g) potato starch
- 1/2 cup (30 g) tapioca flour
- 1/4 cup (40 g) white rice flour
- *optional*: 1 tsp xanthan gum

INSTRUCTIONS:

- Blend together and store in a secure container in a dry place.
- Use in place of all purpose or whole wheat flour in a 1:1 ratio. For extra binding (since there is no gluten) you can add a pinch of xanthan gum depending on the recipe.

TIP: Sometimes substituting gluten-free flour in place of all-purpose flour in a 1:1 ratio doesn't always yield the best results. Because of this, you may want to try substituting other ingredients, such as almond meal, oat flour, and/or rolled oats, to the gluten-free blend to create a more desirable texture.

EXAMPLE: If a recipe calls for 1 cup (136 g) all-purpose flour. You could substitute ½ cup gluten-free flour blend (80 g), ¼ cup almond meal (27.5 g), and ¼ cup gluten-free oat flour (23 g), depending on the recipe.



Nutrition Facts

servings per container	
Serving size	**(98g)**
Amount per serving	
Calories	**120**
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 21g	**8%**
Dietary Fiber 8g	**29%**
Total Sugars 3g	
Includes 0g Added Sugars	**0%**
Protein 8g	
Vitamin D 0mcg	0%
Calcium 14mg	2%
Iron 1mg	6%
Potassium 350mg	8%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2000 calories a day is used for general nutrition advice.

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