Pulse Crop Health Initiative Funded Projects – 2018

1. Hidden Nutrition: Understanding the encapsulation dynamics of the cotyledon cell to optimize consumer acceptability and nutritional benefits of dry beans

   Karen Cichy (PI), USDA-ARS, East Lansing, MI
   Ray Glahn, USDA-ARS, Ithaca, NY
   Donna Winham, Iowa State University, Ames, IA

   Objectives: (1) Characterize the composition of the cotyledon cell wall in a unique set of dry bean germplasm with diverse cooking times and culinary attributes. (2) Evaluate the flour milling quality in dry bean germplasm with diverse cooking times and measure the nutrient bioavailability and consumer acceptability in whole beans and foods made with bean flours. (3) Test the glycemic response of whole beans vs. foods made with bean flours.

2. MP3: More protein, more peas, more profit

   Clare Coyne (PI), USDA-ARS, Pullman, WA
   Rebecca McGee, USDA-ARS, Pullman, WA
   John Miller, Montana State University, Conrad, MT

   Objectives: (1) Determine the genetic variation of protein and mineral nutrient concentration in current cultivars and advanced breeding lines of yellow pea (Genotype x Environment analysis). (2) Identify single nucleotide polymorphisms associated with alleles controlling seed protein concentration in pea using genome wide association studies. (3) Develop and validate breeder friendly markers for increasing seed protein and mineral nutrient concentrations in new yellow pea cultivars.

3. Flavor, nutrition and functional properties of pea protein

   Baraem (Pam) Ismail (PI), University of Minnesota, St. Paul, MN

   Objectives: (1). Produce pea protein isolates (PPI) and hydrolysates (PPH) and determine their structure, molecular interactions, surface properties, and functionality. (2) Identify the aroma and taste compounds in PPI and PPH that provide an undesirable flavor, and elucidate formation pathways to guide protein isolation and processing protocols. (3) Determine the protein digestibility corrected amino acid score (PDCAAS) of PPI and PPH and evaluate their potential to promote a reduction in adiposity using an animal model.

4. Increasing nitrogen fixation potential in pulses for environmental and economic sustainability

   Clain Jones (PI), Montana State University, Bozeman, MT
   Kevin McPhee, Montana State University, Bozeman, MT
   Perry Miller, Montana State University, Bozeman, MT
   Maryse Bourgault, Montana State University, Havre, MT

   Objectives: (1) Assess nitrogen fixation and residual nitrate for a range of pea and lentil lines and cultivars grown in the Northern Plains to allow pulse breeders to identify and breed for higher nitrogen fixing varieties. (2) Determine nitrogen fixation response in lentils from starter potassium plus sulfur fertilizer with and without inoculant. (3) Evaluate the effects of granular inoculant, peat powder seed coat inoculant, and double inoculant (granular plus peat powder, peat powder at 2x rate) on pea nitrogen fixation, residual nitrate-nitrogen, yield, and protein.

5. Development of efficient, genotype-independent gene-editing systems for common bean and chickpea

   Shawn Kaeppler (PI), University of Wisconsin, Madison, WI

   Objectives: (1) Develop a transformation system to deliver gene-editing machinery. (2) Develop an efficient gene-editing process.

6. The effect of food processing on fermentable oligosaccharides from pulse crops in human colon and its microbiota

   Sean Liu (PI), USDA-ARS, Peoria, IL
   Mukti Singh, USDA-ARS, Peoria, IL
   Devin Rose, University of Nebraska, Lincoln, NE

   Objectives: (1) Assess food processing methods with pulse crops that yield lower amounts of fermentable oligosaccharides and that maintain or enhance beneficial microbiota in the colon. (2) Conduct *in vitro* and *in vivo* studies of fermentable oligosaccharides and changes in colonic microbiota.

7. Enhancing the Nutritional and Functional Traits of Dry Bean Through Metabolomics, Genetics, and Breeding

   Phillip McClean (PI), North Dakota State University, Fargo, ND
   Juan Osorno, North Dakota State University, Fargo, ND
   Karen Cichy, USDA-ARS, East Lansing, MI
   James Harnly, USDA-ARS, Beltsville, MD
   Phillip Miklas, USDA-ARS, Prosser, WA

   Objectives: (1) Obtain metabolite fingerprints for a large number (n=300) of advanced breeding lines from the major US market classes of dry beans. (2) Identify genetic factors associated with the major metabolite compounds identified in Objective 1. (3) Perform field trials at five locations (three in WA and two in ND) with advanced breeding lines representing the major Middle American market classes and collect performance data. (4) Correlate specific metabolite fingerprints associated with good end use quality characteristics.

8. Sustainable field pea cropping systems for the Great Plains

   Kraig Roozeboom (PI), Kansas State University, Manhattan, KS
   Lucas Haag, Kansas State University, Colby, KS
   Augustine Obour, Kansas State University, Hays, KS
   Ignacio Ciampitti, Kansas State University, Manhattan, KS
   Zach Stewart, Kansas State University, Manhattan, KS
   John Holman, Kansas State University, Garden City, KS

   Objectives: (1) Determine the relative productivity of spring and winter pea grown across a range of environments and cropping systems in Kansas. (2) Determine relative differences in nitrogen fixation and net nitrogen input to the system between spring and winter pea when grown in Kansas. (3) Evaluate the effect of including peas in Kansas rotations on soil health indicators. (4) Evaluate the effect of incorporating peas on the small-grain segment of Kansas crop rotations.

9. Optimizing pulse protein functionality

   Brennan Smith (PI), University of Idaho, Moscow, ID
   Girish Ganjyal, Washington State University, Pullman, WA

   Objectives: (1) Determine the biochemical composition of starting pulse materials. (2) Optimize extraction protocols for maximum protein solubility. (3) Determine the effects of glucose addition and deamidation on the functional properties of pulse protein isolates. (4) Determine the effects of ultra-sonication and chemical disulfide bond cleavage on pulse protein isolate functionality. (5) Determine the nutritional quality of the experimental treatments through *in vitro* digestibility studies.

10. Sustainability and health impact assessment of US pulses

    Greg Thoma (PI), University of Arkansas, Fayetteville, AR
    Naomi Fukagawa, USDA-ARS, Beltsville, MD
    Peter Arbuckle, USDA-ARS, Beltsville, MD

    Objectives: (1) Establish national-scale benchmark of environmental sustainability across multiple dimensions (climate change, eutrophication, etc.) for the production and consumption of major pulse crops. (2) Submit lifecycle inventory data sets to the National Agricultural Library Digital Commons. (3) Evaluate the environmental sustainability of alternative diets with varying quantities of pulses, working in conjunction with USDA nutritionists to ensure that each alternative diet is nutritionally equivalent. (4) Evaluate environmental sustainability of alternative pulse production management systems, including a consequential lifecycle analysis paradigm focused on the production and health effects of pulses.

11. Mechanisms of dry bean mediated anti-obesogenic activity

    Henry Thompson (PI), Colorado State University, Fort Collins, CO
    Corey Broeckling, Colorado State University, Fort Collins, CO
    Pamela Wolfe, Wolfe Statistical Consulting LLC, Santa Fe, NM

    Objectives: (1) Determine how fat deposition is partitioned in bean-fed versus control-fed mice that are provided isocaloric amounts of diet. (2) Evaluate the extent to which bean consumption affects caloric uptake and the fraction of ingested energy that is excreted in the feces, using a mouse model. (3) Use indirect calorimetry to determine how bean consumption affects respiratory quotient and/or energy expenditure. (4) Examine the role of bean consumption on the activation of AMP-activated protein kinase and its effect on lipid metabolism. (5) Examine functional changes in the gut microbiome mediated by bean consumption, focusing on bile salt hydrolase activity and how this affects farnesoid X receptor (FXR) activity in the ileum.

12. Comparative Analysis of Chickpea, Dry Pea, Lentil and Dry Bean for Human Health Traits

    Henry Thompson (PI), Colorado State University, Fort Collins, CO
    Adam Heuberger, Colorado State University, Fort Collins, CO
    Pamela Wolfe, Wolfe Statistical Consulting LLC, Santa Fe, NM
    Tiffany Weir, Colorado State University, Fort Collins, CO

    Objectives: (1) Determine how energy balance and lipid metabolism are impacted by low- and high-dietary fiber cultivars of chickpea, dry bean, dry pea, and lentil. (2) Determine how pulse consumption affects histologic and molecular characteristics associated with gut health. (3)

Determine whether differences exist in nutrient and small molecule profiles among pulse crops and across low- versus high-dietary fiber cultivars within a given pulse crop.

13. Improving the nutritional value of chickpeas

    George Vandemark (PI), USDA-ARS, Pullman, WA
    Dilrukshi Thavarajah, Clemson University, Clemson, SC

    <u>Objectives:</u> (1) Assess field-grown chickpea breeding lines and varieties for seed concentrations of iron, zinc, fiber, protein, and fatty acids. (2) Identify genetic markers associated with seed concentrations of protein, iron, zinc, and fatty acids. (3) Use diversity panel accessions with desirable nutritional qualities as parents in crosses with commercial varieties and adapted USDA-ARS breeding lines to develop improved germplasm and varieties.