Pulse Crop Health Initiative Funded Projects – Fiscal Year 2020

Breeding Projects

MP3: More protein, more peas, more profit

Clare Coyne (PI), USDA-ARS, Pullman, WA
Rebecca McGee, USDA-ARS, Pullman, WA
Clare Coyne (PI), USDA-ARS, Pullman, WA

Project Start Date: FY2018

Goal: To increase seed protein concentrations in yellow pea cultivars.

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 (GWAS); and (3) Develop and validate breeder friendly markers for increasing seed protein and mineral nutrient concentrations in new yellow pea cultivars.

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

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

Project Start Date: FY2018

Goal: To develop efficient methods for transformation and gene-editing in common bean and chickpea and to utilize these methods to edit health-related traits of interest.

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

Enhancing the nutritional and functional traits of dry bean through metabolomics, genetics, and breeding

Phil 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 N. Miklas, USDA-ARS, Prosser, WA

Project Start Date: FY2018

Goal: To correlate specific dry bean metabolite patterns with important functional and agronomic traits, to identify genetic factors associated with metabolites that distinguish functional traits in different U.S. dry bean market classes, and to develop improved dry bean germplasm that combine important functional traits with sustainable agronomic performance across diverse environments.

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; and (4) Correlate specific metabolite fingerprints associated with good end use quality characteristics.

Improved short season cowpeas and development of unmanned aerial system (UAS) and other phenotyping tools to advance pulse breeding

Seth Murray (PI), Texas A&M University, College Station, TX
Bir B. Singh, Texas A&M University, College Station, TX

Project Start Date: FY2019

Goal: To breed and release new varieties of short season cowpea (black-eyed peas) for producers to profitably incorporate pulses into existing production systems and to develop new high-throughput trait analysis tools to make future breeding, selection, and management of pulse crops more efficient.

Objectives: (1) Determine the yield potential and composition of new short season elite cowpea breeding lines in multiple Texas environments (Genotype x Environment analysis); (2) Advance a breeding pipeline of new second cycle cowpea lines; (3) Evaluate the ability of unmanned aerial systems (UAS) as high-throughput phenotyping tools to estimate biomass, growth, and plant populations of cowpea and other pulses, towards predicting yields in breeding pipelines; and (4) Develop near infrared spectroscopy (NIR) to estimate and predict composition, including protein, fiber, and minerals, of cowpeas and other pulses.

Improving the nutritional value of chickpeas

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

Project Start Date: FY2018

Goal: To develop improved chickpea varieties with superior agronomic traits and nutritional qualities.

Objectives: (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; and (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.

Developing the next generation of flavonoid enhanced dry beans

Phil McClean (PI), North Dakota State University, Fargo, ND
Juan Osorno, North Dakota State University, Fargo, ND
Ray Glahn, USDA-ARS, Ithaca, NY
Phillip N. Miklas, USDA-ARS, Prosser, WA

Project Start Date: FY2020

Goal: To provide basic knowledge of flavonoid chemistry and genetics to enhance the perception of dry beans as a highly valued, healthy crop.

Objectives: (1) Determine the flavonoid content and profile in all the major US dry bean market classes and single color/pattern gene introgression lines; (2) Measure those environmental factors that affect seed flavonoid content in the major US market classes of dry bean; and (3) Identify candidate genes that control seed flavonoid content and their relationship to those genes known to affect bean seed coat color and pattern.

Sustainability Projects

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
Scott Powell, Montana State University, Bozeman, MT

Project Start Date: FY2018

Goal: To enhance nitrogen fixation of pulse crops and increase residual nitrate in the soil for subsequent crops, thereby increasing grain yield, protein, and net economic returns.

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 the nitrogen fixation response in lentils from starter potassium plus sulfur fertilizer with and without inoculant; and (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.

Optimizing nodulation in chickpea for enhanced nitrogen fixation

Audrey Kalil (PI), North Dakota State University, Williston Research Extension Center, Williston, ND
Nonoy Bandillo, North Dakota State University, Fargo, ND

Project Start Date: FY2019

Goal: To improve nodulation and nitrogen fixation in chickpea using diverse rhizobia from the Northern Great Plains and to identify chickpea varieties with superior nitrogen fixing capabilities.

Objectives: (1) Identify rhizobia strains with improved abiotic stress tolerance, nodulation, and N fixation for use as chickpea inoculants; (2) Determine best practices regarding chickpea seed treatment and fertilization for maintaining nodulation and N fixation; (3) Identify breeding lines and existing varieties that have superior nodulation and N fixing capabilities; and (4) Determine variability in host gene expression and underlying genes responsible for enhanced nodulation and nitrogen fixation in chickpea.

Field experiments to incorporate pulse crops in cropping systems and assess soil health and plant water use efficiency

Zachary Kayler (PI), University of Idaho, Moscow, ID
Xi Liang, University of Idaho, Moscow, ID

Project Start Date: FY2019

Goal: To quantify the potential of lentils, chickpeas, or dry peas in rotation or intercropped with barley on soil health, pulse performance, and barley production and to determine pulse responses to water stress to improve management practices in non-irrigated agronomic systems.

Objectives: (1) Determine the soil health and plant physiology responses of lentils, chickpeas, and dry peas grown in rotation and intercropped with barley; (2) Determine short term and seasonal carbon allocation to seeds, roots, and stems; (3) Evaluate the effect of including pulses on barley production; and (4) Assess the impact of water stress on pulse-barley production and on soil health indicators (e.g., organic matter and microbial community).

Using native rhizobia to improve salt-tolerance in field pea

Christopher Graham (PI), South Dakota State University, Rapid City, SD
Sen Subramanian, South Dakota State University, Brookings, SD

Project Start Date: FY2019

Goals: To develop a multi-species (field pea and rhizobia) system that is resistant to increased soil salinity in the Northern Great Plains.

Objectives: (1) Increase the sustainability of field pea production in the Northern Great Plains by creating a more resilient plant-microbiome system resistant to increasing soil salinity; (2) Identify candidate field pea genomes with tolerance to increasing soil salinity; (3) Identify candidate native rhizobia with tolerance to increasing soil salinity; (4) Compare and contrast the efficacy of native rhizobia with commercial inoculants under abiotic stress; and (5) Test the efficacy of different inoculant delivery systems (granular, peat, liquid) from both native rhizobia and commercial inoculants.

Sustainable field pea cropping systems for the Great Plains

Kraig Roozeboom (PI), Kansas State University, Manhattan, KS
Lucas Haag, Kansas State University, Manhattan, KS
Augustin Obour, Kansas State University, Manhattan, KS
Ignacio Ciampitti, Kansas State University, Manhattan, KS
Zach Stewart, Kansas State University, Manhattan, KS
John Holman, Kansas State University, Manhattan, KS

Project Start Date: FY2018

Goal: To develop sustainable pea cropping systems for the central Great Plains.

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; and (4) Evaluate the effect of incorporating peas on the small-grain segment of Kansas crop rotations.

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

Project Start Date: FY2018

Goal: To enhance the sustainability of the global food supply through optimized production of pulses and to discover and promote the health and nutritional benefits of regular pulse consumption.

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; and (4) Evaluate the environmental sustainability of alternative pulse production management systems, including a consequential lifecycle analysis paradigm focused on the production and health effects of pulses.

Assessment of soil health and nitrogen economy in lentil and pea cropping systems

Audrey Kalil (PI), North Dakota State University, Williston Research Extension Center, Williston, ND
Frankie Crutcher, Montana State University Eastern Agricultural Research Center, Sidney, MT

Project Start Date: FY2020

Goal: To identify and improve crop rotation length and crop sequence that maximizes the soil health and nitrogen fixing benefits of peas and lentils within the context of a cropping system.

Objectives: (1) Develop cropping systems that improve soil health through inclusion of peas or lentils; (2) Determine the effect of crop sequence and rotation length on nodulation and root rot in peas and lentils; (3) Determine if yield and protein of small grain crops can be sustained following field pea or lentil using soil nitrogen credits in a no-till, semi-arid cropping system.

Winter peas in the wheat-fallow region of the Pacific: Benefits to soil health and cropping systems

Timothy Paulitz (PI), USDA-ARS, Pullman, WA
William Schillinger, Washington State University, Lind, WA
Jeremy Hansen, USDA-ARS, Pullman, WA

Project Start Date: FY2020

Goal: To determine the agronomic potential and water use of winter pea in rotation with winter wheat and the potential of winter pea to enhance soil health in wheat-based cropping systems.

Objectives: (1) Demonstrate agronomic stability of winter peas in various cropping zones of the dryland Pacific Northwest; and (2) Describe the unique microbiome of the winter pea rhizosphere and roots and the impacts on soil health for subsequent wheat production.

Carbon footprint and greenhouse gas emissions under no-till pulse cropping systems

Upendra Sainju (PI), USDA-ARS, Sidney, MT

Project Start Date: FY2020

Goal: To generate information on the sustainability of pulse crops grown in rotation with cereal crops under dryland cropping systems in the northern Great Plains.

Objectives: (1) Measure soil organic and inorganic carbon concentrations at the 0-120 cm depth, carbon sequestration potential, and carbon footprint of pulse crops; (2) Determine nitrogen supplying capacity of pulse crops; (3) Quantify greenhouse gas emissions throughout the year under pulse crops and crop rotations; (4) Measure grain and biomass yields of pulse crops and spring wheat; and (5) Calculate global warming potential and greenhouse gas intensity of pulse crops and the rotation system.

Food Technology Projects

Optimization in the production of protein hydrolysates from chickpea as novel functional food ingredients in the prevention of type-2 diabetes

Elvira de Mejia (PI), University of Illinois, Urbana, IL

Project Start Date: FY2019

Goal: To optimize the digestion conditions of chickpea proteins to compare their antidiabetes potential and to characterize the peptide composition of chickpea protein hydrolysates to generate ingredients with health benefits suitable in foods.

Objectives: (1) Optimize the processing conditions to generate protein hydrolysates with antidiabetic potential from chickpea proteins as well as to generate major peptides produced from chickpea varieties with specific amino acid sequences and predicted bioactivity; (2) Evaluate the techno-functional properties of chickpea protein hydrolysates and their incorporation in a baked snack food matrix; and (3) Determine the effect and mechanism of action of a chickpea protein hydrolysate in preventing type-2 diabetes using a murine model of diet-induced metabolic dysfunction.

Tailoring processing strategies to produce the new generation of chickpea proteins and prebiotic oligosaccharides

Juliana Maria Leite de Moura Bell (PI), University of California, Davis, California
Daniela Barile, University of California, Davis, California
David Mills, University of California, Davis, California

Project Start Date: FY2019

Goal: To use an advanced mass spectrometry guided extraction process to produce chickpea protein concentrates (proteins and carbohydrates) with improved functionality and to convert chickpea processing byproducts (fiber and hulls) into selective prebiotic oligosaccharides.

Objectives: (1) Produce chickpea protein concentrates with increased protein content and functionality, along with diverse oligosaccharide composition, through the use of the aqueous (AEP) and enzyme-assisted aqueous extraction process (EAEP); (2) Convert chickpea hulls and the insoluble fiber generated by the AEP/EAEP of chickpea flour (byproduct) into prebiotic oligosaccharides using a modified Fenton reaction; and (3) Evaluate prebiotic and anti-infective actions of the skim fractions (proteins/peptides + carbohydrates) produced during the AEP/EAEP processing, and of the bioactive oligosaccharides produced by the conversion of chickpea hulls and insoluble fraction.

Flavor, nutrition and functional properties of pea protein

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

Project Start Date: FY2018

Goal: To characterize the flavor, functionality, nutritional quality, and physiological properties of pea protein subjected to targeted isolation and enzymatic modification and to identify ways to increase pea protein's success in replacing partially or wholly traditional proteins in various food applications.

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; and (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.

Impact of Storage on Functionality and Nutritional and Phytochemical Compositions of Pea, Lentil and Chickpea

Clifford Hall (PI), South Dakota State University, Brookings, SD
Atanu Biswas, USDA-ARS National Center for Agricultural Utilization Research, Peoria, IL

Project Start Date: FY2019

Goals: To understand how storage practices affect the functionality and nutritional composition of pulses and to provide the food industry with guidance in the handling of pulses during long-term storage.

Objectives: (1) Assess the flour, protein and starch functionality of pulses stored under (a) ambient conditions typical of North Dakota, Montana and the Palouse region for up to 4 years and (b) combinations of several relative humidities and temperatures typical of environments where pulses are exported; (2) Determine the nutrient and phytochemical compositions of the stored pulses; (3) Assess the functionality and nutrient/phytochemical composition of different pulse cultivars stored under harsh storage conditions identified in Objective 1; and (4) Characterize the impact of pulse storage on the application of flour in crackers and cookies.

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
Amanda Ramer-Tait, University of Nebraska, Lincoln, NE
Andrew Benson, University of Nebraska, Lincoln, NE

Project Start Date: FY2018

Goal: To examine the effect of various methods of processing of pulses on digestive health and barriers to pulse consumption.

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; and (2) Conduct *in vitro* and *in vivo* studies of fermentable oligosaccharides and changes in colonic microbiota.

Optimizing pulse protein functionality

Michael Colle (PI), University of Idaho, Moscow, ID
Girish Ganjyal, Washington State University, Pullman, WA

Project Start Date: FY2018

Goal: To increase the functionality of pulse protein isolates through optimization of processing and biochemical modifications while maintaining or improving nutritional quality.

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; and (5) Determine the nutritional quality of the experimental treatments through *in vitro* digestibility studies.

Improving pulse protein properties for expanded functionality using naturally derived polymeric polyphenols

Joseph Awika (PI), Texas A&M University, College Station, TX
Audrey Girard, Texas A&M University, College Station, TX
Miara Riaz, Texas A&M University, College Station, TX

Project Start Date: FY2020

Goal: To significantly expand pulse protein functionality and value as food ingredients, specifically by overcoming their limited functionality as texturized vegetable proteins.

Objectives: (1) Establish effect of temperature and plasticizer on pea protein cross-linking efficiency with tannins; (2) Determine the effect of thermo-mechanical conditions on the solubility, rheology, and texture of tannin cross-linked pea protein; and (3) Determine effect of tannin cross-linking on functional properties of pea proteins in select products.

Development of meat analogues with germinated pulse protein extracts

Bingcan Chen (PI), North Dakota State University, Fargo, ND
Minwei Xu, North Dakota State University, Fargo, ND

Project Start Date: FY2020

Goal: To develop and scale up meat analogues with protein extracts from germinated pulses, including chickpea, lentil, and dry pea.

Objectives: (1) Germinate chickpea, lentil, and dry pea in pilot scale; (2) Evaluate the functionalities of pulse protein isolates after germination; (3) Develop texturized meat analogues with germinated pulse protein isolates; (4) Evaluate the quality of meat analogues based on sensory, texture, and digestibility; and (5) scale up meat analogue process in pilot scale.

Effects of extraction methods on lentil and dry beans extract composition and structural modifications: from extraction efficiency, functional and biological properties to fouling of industrial UHT equipment

Juliana Maria Leite de Moura Bell (PI), University of California, Davis, California
Daniela Barile, University of California, Davis, California
David Mills, University of California, Davis, California

Project Start Date: FY2020

Goal: To identify an environmentally friendly extraction using mechanical treatments, water, and target enzymes to simultaneously extract protein and carbohydrates from lentil and dry bean flours.

Objectives: (1) Fractionate, quantify, and characterize protein classes from lentils and dry bean based on their solubility to better understand the effects of ultra-high temperature (UHT) treatment on denaturation of each protein class; (2) Produce lentil and dry bean protein extracts with increased protein content, functional, and biological properties using the aqueous extraction process (AEP) and enzyme-assisted aqueous extraction process (EAEP); (3) Convert the fiber-rich fraction generated by the AEP/EAEP of lentil and dry bean flour into prebiotic oligosaccharides; (4) Evaluate anti-hypertensive, anti-diabetic, prebiotic, and anti-infective actions of protein extracts and of the bioactive oligosaccharides; (5) Evaluate thermal behavior and structural modifications of lentil and dry bean protein extracts; and (6) Evaluate the effects of preheating temperatures and holding time prior to the UHT treatment on protein denaturation and fouling formation.

Effects of roasting parameters on the functional and organoleptic properties of lentil flours

Girish Ganjyal (PI), Washington State University, Pullman, WA
Rebecca McGee, USDA-ARS, Pullman, WA

Project Start Date: FY2020

Goal: To investigate the effect of roasting on the functional and organoleptic properties of lentil flours and their potential use in food products.

Objectives: (1) Evaluate the effect of roasting of lentils flours under a range of processing conditions on their chemical, functional, and nutritional properties; (2) Examine the performance of roasted lentil flours in selected food products (cookies; sheeted and fried chips) and assess the correlation between raw material properties and final product quality; and (3) Evaluate the physical characteristics and sensory attributes of the food products produced under varying roasting conditions.

Developing and utilizing functionally enhanced pulse proteins as novel food ingredients

Yonghui Li (PI), Kansas State University, Manhattan, KS
Kadri Koppel, Kansas State University, Manhattan, KS

Project Start Date: FY2020

Goal: To rationally tailor the structure of pulse protein molecules for more desirable functionalities and end-uses and to develop new protein-based ingredients and food products.

Objectives: (1) Modify pulse (pea, lentil, and chickpea) proteins through acylation and/or glycosylation to enhance functional properties; (2) Investigate physicochemical characteristics of the modified proteins and establish protein structure-function relationships; and (3) Develop and characterize food products with the functionally enhanced pulse protein ingredients.

Dough rheology, baking performance, and bread sensory quality of pulse-fortified whole wheat flours

Yonghui Li (PI), Kansas State University, Manhattan, KS
Kaliramesh Siliveru, Kansas State University, Manhattan, KS
Kadri Koppel, Kansas State University, Manhattan, KS

Project Start Date: FY2020

Goal: To optimize processing conditions and formulations of whole grain wheat bread products fortified with pulse flours and to develop quality and nutritious foods.

Objectives: (1) Produce and characterize whole and dehulled pulse flours with different particle sizes from dry peas, chickpea, lentils, and dry beans; (2) Investigate physicochemical and rheological properties of whole wheat dough fortified with pulse flours of different types, compositions, and particle sizes; (3) Examine bread-making performances of whole wheat flour fortified with the pulse flours; (4) Optimize the quality and sensory profiles of breads from pulse-fortified whole wheat flour with dough improvers; and (5) Establish the relationships among pulse flour characteristics, dough properties, and bread quality and sensory attributes.

Thermal and nonthermal processing of pulse protein concentrates: Impact on functionality and nutritional value

Carmen Moraru (PI), Cornell University, Ithaca, NY
Alexandra Hall, Cornell University, Ithaca, NY

Project Start Date: FY2020

Goal: To evaluate the effects of high-pressure processing on the structure, function, and digestibility of pulse protein concentrates to uncover new opportunities for pulse ingredients in food manufacturing and product development.

Objectives: (1) Evaluate the effects of thermal and nonthermal high pressure processing (HPP) treatments on protein in vitro digestibility and trypsin inhibitor activity for several pulse (pea, lentil, faba bean) proteins; (2) Characterize the impact of thermal and HPP treatments on the structure and functionality of pulse proteins; (3) Develop combination treatments that maximize functionality of pulse protein concentrates while effectively inactivating antinutritional factors.

Human Health Projects

Pulse Resistant Starch: Interplay Between Processing, the Microbiome and Health

Darrel Cockburn (PI), The Pennsylvania State University, University Park, PA

Project Start Date: FY2019

Goal: To examine the factors that influence health benefits received from pulse resistant starches as mediated by the gut microbiome

Objectives: (1) Investigate the influence of resistant starch from different pulses, processing steps, and dietary history using *in vitro* fecal fermentation studies to measure microbial diversity and butyrate production; and (2) Investigate the influence of resistant starch from different pulses, processing steps, and dietary history using defined microbial fermentations to measure microbial diversity and butyrate production.

Understanding the Pulse-Gut relationship and its role in modifying systemic inflammation and insulin sensitivity in humans

Indika Edirisinghe (PI), Illinois Institute of Technology, Bedford Park, IL
Amandeep Sandhu, Illinois Institute of Technology, Bedford Park, IL
Britt Burton-Freeman, Illinois Institute of Technology, Bedford Park, IL

Project Start Date: FY2019

Goal: To determine the role of pulse food consumption in a healthy diet on key health endpoints associated with the prevention of diabetes mellitus and cardiovascular disease development in at risk populations.

Objectives: (1) Characterize indices of systemic inflammation and gut microbiota composition and function after chronic (12 weeks) intake of pulses compared to control diet in human over weight/obese – insulin resistant (OW/OW-IR) participants; and (2) Characterize dietary- and microbial-derived metabolite pools after regular intake of pulses (12 weeks) in human OW/OB-IR participants compared to control diet.

Gut microbiota dependent and independent impacts of dietary pulses on pre- and postprandial metabolism and inflammation in overweight/obese humans

Mary Miles (PI), Montana State University, Bozeman, MT
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Seth Walk, Montana State University, Bozeman, MT
Colleen McMilin, Montana State University, Bozeman, MT
Wan-Yuan Kuo, Montana State University, Bozeman, MT
Mark Greenwood, Montana State University, Bozeman, MT

Project Start Date: FY2019

Goal: To determine gut microbiome dependent and independent impacts of pulse consumption on metabolic resilience and metabolic risk profiles for type 2 diabetes and cardiovascular disease risk.

Objectives: (1) Determine the impact of pulse (green lentil and black bean) consumption on postprandial triglyceride and inflammation responses to a high-fat meal challenge; (2) Determine the extent to which the gut microbiome and changes in the gut microbiome induced by pulse consumption influence health impacts; and (3) Measure metabolomic profiles to elucidate underlying mechanisms linking pulse consumption to improved health.

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

Project Start Date: FY2018

Goal: To compare the anti-obesogenic activity of low and high dietary fiber cultivars of dry bean, chickpea, dry pea, and lentil and to assess how these pulses affect histological and molecular characteristics associated with gut health and functional activity of the gut associated microbiome

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; and (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.

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

Project Start Date: FY2018

Goal: To identify the components of beans responsible for health benefits, to screen and improve bean germplasm for value-added health traits, and to develop biomarkers for use in the clinical evaluation of health benefits arising from bean consumption.

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; and (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.

Identifying the role of pulses in a healthful diet: Metabolomic signatures of dietary pulses and their benefits on cardiometabolic risk factors

Brian Bennett (PI), USDA-ARS, Davis, CA
John Newman, USDA-ARS, Davis, CA
Francene Steinberg, University of California-Davis, Davis, CA

Project Start Date: FY2020

Goal: To evaluate how pulse digestion/microbial fermentation influence the circulating and excreted metabolome and how this is associated with changes in the gut microbial community and glycemic control in overweight-obese individuals fed a pulse rich diet.

Objectives: (1) Using a randomized controlled feeding study, develop food exposure signatures for pulse enriched diets; and (2) Determine if a pulse enriched diet meeting the USDA's Dietary Guidelines improves glucose regulation in persons at-risk for metabolic disease.

Pulse consumption improves gut health, metabolic outcomes, and bone biomarkers of postmenopausal women

Edralin Lucas (PI), Oklahoma State University, Stillwater, OK
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Sam Emerson, Oklahoma State University, Stillwater, OK
Jiangchao Zhao, University of Arkansas, Fayetteville, AR
Guadalupe Davila-El Rassi, Oklahoma State University, Stillwater, OK

Project Start Date: FY2020

Goal: To evaluate the prebiotic potential of a pulse-based diet to beneficially modulate the gut microbiome and improve gut health and metabolic and bone biomarkers in postmenopausal women.

Objectives: (1) Determine the effects of consuming a pulse-based diet for 3 months on gut bacterial populations and markers of gut health in postmenopausal women; (2) Examine the association between pulse-induced changes in gut microbiome and markers of gut health and metabolic and bone biomarkers; and (3) Identify patterns as well as barriers and facilitators of pulse consumption in this sample of postmenopausal women.

Protective effects of dietary pulse flours on the transgenerational influence of maternal obesity

Todd Rideout (PI), State University of New York at Buffalo, Buffalo, NY
Michael Buck, State University of New York at Buffalo, Buffalo, NY
Mulchand Patel, State University of New York at Buffalo, Buffalo, NY

Project Start Date: FY2020

Goal: To understand the influence of maternal pulse consumption on improving maternal health and preventing negative offspring health outcomes in obese pregnancies.

Objectives: (1) Characterize the protective influence of dietary pulse flour consumption on maternal obesity and fetal health using a diet-induced obese rat model; and (2) Evaluate the influence of maternal pulse consumption during pregnancy and lactation in protecting against obesity and obesity-induced gut microbiome dysbiosis in offspring throughout the life-course.

National consumer survey of pulse consumption and views

Donna Winham (PI), Iowa State University, Ames, IA
Mack Shelley, Iowa State University, Ames, IA
Andrea Hutchins, University of Colorado, Colorado Springs, CO

Project Start Date: FY2020

Goal: To grow the consumer appeal of pulses and thereby increase their consumption to improve human diet and resulting health outcomes.

Objectives: (1) Use nationwide consumer surveys to identify national-level adult consumer knowledge, attitudes, and practices regarding pulse crops, barriers and motivators to their use, general interest in plant-based protein, and the influence of environmental sustainability on food purchases; and (2) Identify similar data from a low-income population, including additional information regarding experience with pulses through food assistance programs.