

# 2016 Utah State University Combined Research and Extension Annual Report of Accomplishments and Results

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## I. Report Overview

### 1. Executive Summary

#### GLOBAL FOOD SECURITY AND HUNGER

##### Horticulture

**Research Impact:** B. Black is looking at ways of expanding opportunities for fruit production in Utah. High density tart cherry experimental orchards were established in 2010, 2012 and 2013. A mechanical harvester was used to harvest the 2010 and 2012 plantings, with the first mechanical harvest of the 2013 planting to take place in 2016. Yields in several single-leader treatments are meeting commercial thresholds. Additional modifications to the machine were made that continue to improve performance.

**Research Impact:** D. Drost has been studying vegetable cropping opportunities: crop rotation and cover crop strategies. Winter and summer planted cover crops rotational studies were conducted to evaluate how selected winter and summer grass, legume, and broadleaf influences soil properties, weed pressure, and vegetable (broccoli, green bean, sweet corn) growth in a certified organic production system. Growth and yield responses for all crops were due to low soil nitrogen (N) levels. All vegetable crops grown were responsive to plant produced N. Growers report that 55% of their acreage is being grown with consideration of crop rotation, nitrogen status, field border management, and integrated pest management strategies. These growers also report that onions grown with sustainable methods have few thrips to manage. Sixty percent of Utah growers report they are now using a reduced nitrogen program to help manage onion thrips and reduce the incidence of Iris Yellow Spot Virus, with minimal impact on productivity. Lower N applications saves on fertilizer and pesticide costs, since thrips pressure is related to nitrogen.

**Research Impact:** J. Reeve and R. Ward are looking at ways of improving soil quality and sustainable production in Utah farming systems. A ninth year of soil and tree nutritional data and yield was collected from the organic peach orchard at Kaysville. Results show that weeds, not lack of fertility, are the primary restraint on tree growth in establishing organic peach trees. However, planting birdsfoot trefoil in the alleyways as opposed to grass may reduce the need for expensive weed management in the establishment of organic peaches.

**Research Impact:** B. Black is studying integrated fruit management systems. A novel diamide insecticide cyclaniliprole (Harvanta, ISK Biosciences) was evaluated for control of western cherry fruit fly in comparison with a registered diamide, Exirel, and a spinosyn, Delegate, both commonly used in the cherry industry. All 3 insecticides were effective adulticides, but only Harvanta and Delegate completely prevented fruit injury. None stimulated spider mites after 4 applications.

A biofix formula for codling moth based on latitude and elevation predicted first moth trap capture within 1 to 3 days for 11 northern Utah orchards, which is acceptable for pest management application; however, the predictive variance was unacceptable for 6 southern Utah orchards, -11 to 5 days. A plastic translucent trap, Olson yellow sticky strip (YSS), out-performed Pherocon (cardboard) and Alpha Scents (plastic) yellow sticky cards in attracting and retaining western cherry fruit fly adults. YSS was particularly effective in attracting gravid females. Ammonium carbonate bait added to traps increased fly capture by 3.1× in sweet, and 6.9× in tart cherry trees.

A trial was conducted to evaluate chemical and biological control products for fire blight. The antibiotics (streptomycin and kasugamycin) performed very well as did the biological control product "Blossom Protect". Two new experimental products were tested for fire blight control. Both gave better results than

the antibiotics.

**Research Impact:** B. Black is looking at ways of improving economic and environmental sustainability in tree fruit production through changes in rootstock use. Some apple rootstocks are prone to break at the graft union due to an increase in rigidity and brittleness. However, the brittleness was not associated with changes in hydraulic conductance. Application of several commercial growth regulator formulations during growth could increase the graft area, and consequently increase the strength of the union. Cherry rootstocks showed differential tolerance to drought stress cycles, where Gisela 5 rootstocks showed slower recovery to drought cycles than similar-sized plants of Gisela 3 or Gisela 12.

**Success Story:** Devastating plant problems at Sevier County nurseries were resolved with help from Extension. One nursery saved over 1,500 tomato plants when soil and plant tissue analysis by USU Analytical Lab (USUAL) verified soil nutrient problems. The owner followed Extension and USUAL recommendations and easily corrected nutrient problems which saved the plants.

**Success Story:** Evaluation of several years of records show that most home owners have applied excessive amounts of phosphorus to their soils while farmers in the valley have soils that are deficient in phosphorus (P) and potassium (K). In 2016, 18 homeowners took and submitted 17 soils samples for analysis, 77.8% of samples had excessive P, 22.2% had low P and 5.6% had low K. Homeowners testing soils know how to interpret results, how to properly amend their soils, and how much fertilizer and other nutrients to apply to maintain landscapes, grow high yield vegetable, and protect water quality.

**Success Story:** Juab County Extension conducts a public weed awareness program. This year, 355 individuals increased their knowledge in the areas of weed control, pesticide safety and use. This represents nearly 15% of all the households in the county. During this year's program, \$15,930.00 was saved by program participants and 177 acres of weeds have been sprayed.

**Success Story:** Mountain States Oilseeds contracts 20,000 acres of safflower annually from Northern Utah and Southern Idaho growers. Three years ago the majority of the safflower raised was S-208 or CW 990L varieties. Today, because of USU safflower variety trials, 98% of their contracted safflower is S-333. Over the past 7 years in our variety trails, S-333 has yielded 26 pounds per acre more than S-208. Additionally, the color scores are superior and percent oil is higher with S-333, thus making it more valuable per pound. Twenty-six additional pounds per acre on 20,000 acres is 520,000 pounds. Superior color score and oil content make S-333 variety worth approximately 6 cents more per pound which equals \$31,200 per year that growers are making by planting a safflower variety that has been tested under Utah growing conditions.

#### Crops

**Research Impact:** J. Carmen is doing cytological and molecular characterizations of reproduction in sexual and apomictic *Boechera* (Brassicaceae). Twenty-two inter-related *Boechera* taxa were studied embryologically. Among these, sexual reproduction and three types of apomictic reproduction (*Antennaria* and *Taraxacum*-type diplospory and *Hieracium*-type apospory) were observed. Eight taxa consistently produced genetically-reduced embryo sacs from surviving megaspores of meiotic tetrads, which indicates that they may be obligately sexual. The remaining taxa were apomictic with various ratios of apomictic to sexual embryo sac formation occurring. Many taxa exhibited high-frequency *Taraxacum*-type diplospory and/or *Hieracium*-type apospory. *Antennaria*-type diplospory was only infrequently observed and occurred only in *B. retrofracta* x *stricta*. Pseudogamy (central cells of apomictic embryo sacs requiring fertilization for seeds to form) was confirmed by single seed flow cytometry.

**Research Impact:** J. Creech and colleagues are studying compost carryover and cover crop effects on soil quality, profitability, and cultivar selection in organic dryland wheat production. Studies are being conducted at a number of sites in Utah, Wyoming and Washington. Wheat grain yields ranged from 522 kg/ha in plots with no compost to 2,354 kg/ha in the plots with compost at 50 Mg/ha. Soil pH values ranged from 8.47 to 8.57 with the lowest recorded with the use of compost at 50 MG per ha. At the greatest rate, there was increased availability of nutrients for crop use and improved soil environment for microbial activities. Microbial activity (dehydrogenase and phosphatase enzymes activities) was enhanced following the application of compost, as measured by an increase in. Soil basal respiration as well as the readily mineralizable carbon were highest in the plots with 50 Mg of compost per ha. Respiration per unit microbial biomass was highest in plots with 50 Mg compost, thus suggesting increased microbial growth coupled

with increased C immobilization in the short-term. The metabolic quotient was highest in plots with 50 Mg of compost, suggesting increased microbial activity but at a lower efficiency than microbes in non-amended plots.

**Research Impact:** D. Hole is breeding and evaluating sustainable winter barley cultivars for feed and malting with the objective to develop cultivars of winter barley with improved yield, test weight, straw strength, disease and insect resistances and other agronomic and quality characteristics for production in Utah with irrigated or non-irrigated conditions. UT10830-1 was the highest yielding at 177 bu/ac, followed by DH120232 from the Oregon State doubled haploid population yielding 175 bu/ac, and lastly the winter barley yield of 143 bu/a. Hole is also trying to develop and utilize Doubled Haploid (DH) populations to speed improvement of winter 2-row malting barley. Doubled haploids from Oregon State University performed generally well in Logan in 2016. Only minor winter kill was noted but additional years will be necessary to assess low temperature tolerance

**Research Impact:** D. Hole is developing and testing wheat cultivars and germplasm for changing environments. The goal is to develop dryland hard red and hard white winter wheat cultivars which possess qualities that make them attractive to producers, millers, bakers, and consumers. The highest yield line was UT10806-7 with a nursery average yield of 106.2 bu/ac. The nursery average yield for all lines was 75.6 bu/ac up 10 bu/ac over the previous year nursery average. This was the result of more spring precipitation, but that also increased stripe rust infection in the crop. The cultivar Golden Spike, at 72.0 bu/ac was the highest named cultivar based on its excellent resistance to stripe rust. The highest yield named cultivar was a recent release from University of Idaho, UI Silver. All elite lines demonstrated acceptable quality based on experimental milling and baking.

Irrigated yield trials of hard winter wheat cultivars and breeding lines planted previous to the beginning of this project were harvested. Selections were made from segregating populations. The primary selection was resistance to stripe rust and an early and persistent infection level created ideal conditions for phenotyping this trait. The breeding line, UT10821-3, had an average yield of 101.4 bu/ac and demonstrated continued excellent resistance to stripe rust. It also had less than 2% infection in the inoculated dwarf bunt disease nursery. Greenville yielded 86.3 bu/ac as the most stripe rust resistant release from this program for irrigated production. It had a low, but significant incidence of the disease this year while the most recent susceptible cultivar release, Garland, yielded 54.4 bu/ac, a yield greatly impacted by the disease.

**Research Impact:** J. Norton is studying the functional genomics and ecology of nitrogen mineralization and nitrification by soil bacteria. The response of nitrification to ammonium substrate concentration and temperature was determined using an ammonia oxidizing bacteria (AOB) specific inhibitor to distinguish the contribution of AOB and ammonia oxidizing archaea (AOA). Soils were sampled from cornfield plots that had been treated for four years with contrasting nitrogen sources: control (no additional N), ammonium sulfate at two rates and compost. Ammonia oxidizing bacteria were more responsive than archaea to ammonium fertilizers while the archaea were competitive under low ammonium levels. The relative contribution of ammonia oxidizing archaea to nitrification increased with increasing temperature. Nitrification potential and net rates were stimulated for one month after fertilization with ammonium sulfate compared to relatively lower and stable rates in control and compost treated soils. The proportion of nitrification due to AOA was lowest at 5°C, increased with temperature, and was near to 100% at 50°C; optimum temperature was 41°C for AOA versus 31°C for AOB.

Norton's team also investigated the influence of organic and inorganic nitrogen (N) fertilizers on nitrite oxidizing bacteria (NOB) in soils from silage corn field plots that received contrasting N treatments. Nitrogen fertilizers strongly stimulated the rates of potential nitrite oxidation. The nitrifying community was not altered after the first year of fertilization, but was significantly shifted by four years of repeated application of ammonium fertilizers. The only nitrite oxidizers recovered in all soil samples were from the genus Nitrospira. Understanding the response of both ammonia oxidizers and nitrite oxidizers to N fertilization may initiate or improve strategies for mitigating potential environmental impacts of nitrate production in agricultural soils.

**Research Impact:** M-K. Kim is studying the effects of crop insurance on farmers' production behavior focusing on prevented plantings (PP), late planting (LP) and trend adjusted Actual Production History

(APH). Crop insurance can increase the likelihood of PP claims even though farmers can choose LP and may alter farmers' decision choices in the selection of PP or LP. A farmer with higher insurance coverage would tend to choose PP statistically more often, i.e., exhibit moral hazard. If the farmer decides not to plant the crop (after appraised by an agency), the farmer receives a PP indemnity. LP is an option for the farmer to plant the crop and still maintain the crop insurance when the farmer fails to plant crop by the final planting date. A second option with crop insurance is when a farmer fails to plant first crop due to adverse events such as excess soil moisture or drought, the farmer declares prevented planting (PP), receives PP indemnity, and either leaves the acreage unplanted or plants a second crop (SC), e.g., soybean for corn. In the case of planting a SC, the farmer receives 35% of PP indemnity. Late planting (LP) is another option that a farmer may take when s/he fails to plant (first) a crop during the normal planting period. However, by choosing LP, the farmer does not receive a "full" PP indemnity. The current PP provision fails to provide farmers with an incentive to plant SC (99.9% of PP claiming farmers do not plant SC). Adjusting PP payment encourages farmers to plant SC. The stochastic simulation shows that most of farmers begin planting SC with 50% of PP payment.

**Success Story:** The Extension Agronomy team conducted a formal assessment of the combined impact of all Extension agronomy programs at USU. The survey was conducted at four major crop schools. The farmers in attendance reported that USU Extension agronomy programs over the past five years helped them increase yield of small grains, corn, and alfalfa (including other forages) by an average of 7.4%, annually. Over approximately 104,000 acres represented by these growers, (just over 11% of Utah's cropland) that directly results in \$5.8 million in added value annually, and nearly \$10 million per year when considering indirect and induced (off-farm) effects.

**Success Story:** Producers seek information from USU Extension on livestock rations and nutrition, hay testing and marketing. Summer annual hay crops are often grown in rotation with alfalfa to provide livestock forage. But these crops can accumulate toxic concentrations of nitrates which levels can cause abortions and death in livestock. Abundant hay supplies in 2016 depressed hay prices especially for feeder hay. Fourteen producers requested hay quality testing to help them market their hay. Seventeen forage lots (9 producers) were tested for nitrates and 40 lots (14 producers) totaling 2070 tons were tested for hay quality. Of forages tested for nitrates, no lots had very high nitrates which would likely have resulted in animal deaths if fed, 5 lots had marginal levels which may have caused abortions but could be used if mixed with other feeds and fed to non-pregnant animals. Producers were more successful in avoiding high nitrate forages than in 2015. There were 13 lots of hay tested in the premium and 5 in the supreme quality grades. Producers marketed premium and supreme quality hay for higher prices and received \$27,714 more in revenue. Producers saved an estimated \$3,650 in fewer aborted calves from nitrate poisoning.

**Success Story:** Increased understanding of soil fertility and salinity helps farmers to efficiently use commercial fertilizers and manure resources to improve crop production, maximize profits and minimize nutrient pollution. Few farmers test soils for nutrient needs. Most use a mix of nutrients designed for the "average" field. An Extension agent encouraged soil testing and helped 13 farmer test 27 fields totaling 2054 acres interpret the research based recommendations. Farmers saved \$25.82 per acre on average by soil testing and not purchasing unneeded nutrients for a total savings of \$53,034. By not applying an average of 50 pounds of unneeded nutrients per acre, 51 tons of unnecessary nutrients were kept out of the environment.

#### Beef

**Research Impact:** D. Feuz and a graduate student have been studying the optimal cow size for intermountain cattle ranches. Three resource bases were considered with full supplemental winter feeding time varying from zero, to 90, to 180 days. Cow weights varied from 1,000 to 1,200 to 1400 pounds. Linear programming was used to solved for the optimal cow size on each resource base. The optimal cow size for the zero and 90-day winter feeding ranches was a 1,400 lb mature cow. However, on ranches where cows must be fed 180 days, a 1,000 lb cow was economically optimal. Therefore, the optimal cow size does vary with the resource base.

**Research Impact:** J. MacAdam is studying the use of irrigated perennial legume pastures for dairy and beef production in the Intermountain West. Her group found that gains of steers were significantly greater

on birdsfoot trefoil than on cicer milkvetch. When grass pastures were available, gains on birdsfoot trefoil were also higher than gains on a combination of tall fescue and meadow brome grass pastures. Additional studies found Birdsfoot trefoil ribeye steaks were liked for most characteristics as well as the ribeye steaks of grain-finished beef, while the ribeye steaks of grass-finished beef were less well-liked than the ribeye steaks of birdsfoot trefoil or grain-finished beef. The omega-3 fatty acid concentration of steaks of the birdsfoot trefoil- and grass-finished beef were similar and higher than the omega-3 fatty acid concentration of steaks of the grain-finished beef. The relative methane emissions from cattle on a feedlot diet were compared with cattle on grass, birdsfoot trefoil and cicer milkvetch pastures. Enteric methane was significantly less on perennial legume pastures (birdsfoot trefoil and cicer milkvetch) than on meadow brome grass pastures.

**Success Story:** Three hundred and forty-seven people who manage 4,200 head of beef cattle attended Range Livestock Workshops (RLW). Ninety-four percent of the RLW attendees indicated the overall quality of the workshop to be excellent or higher, 92% stated that the workshop provided new skills, 85% modified their opinion and/or attitudes, and all participants said they will improve their advice they will give to others as a result of attending the RLW.

**Success Story:** Fifty-three attendees at the Cowman's Reproduction Workshop manage 4,586 head of beef cattle. All CRW attendees indicated the overall quality of the workshop to be excellent or higher. Most importantly, 67% of the CRW attendees from previous years have implemented reproductive management changes in their herds and over 53% have seen improvements in herd reproduction.

#### Dairy

**Success Story:** The USU Extension Dairy Specialist and his team have done three statewide surveillance projects of bulk tank milk from most dairy farms in Utah, testing for several important diseases (mycoplasma, Johne's disease, and/or BVD.) For the first time during 2015, due to the follow up and outreach with farms testing positive for mycoplasma, Johne's disease, and/or BVD, Utah became one of a few states to have the state mean Somatic Cell Count in all bulk tank milk less than 175,000/ml. This reflects continued improvement in milk quality.

**Research Impact:** J-S. Eun has been studying ways to improve feed efficiency in dairy and beef cattle to enhance productive and environmental performance. His group has investigated whether Holstein dairy cows supplemented with N-acetyl-L-methionine (NALM), a rumen-protected methionine derivative, would increase milk production by increasing N and energy utilization efficiencies. Overall results from the study suggest that supplementing NALM to lactating dairy cows in mid to late lactation would have minor impact on lactational performance, but it would be beneficial to rapidly growing beef cattle.

**Research Impact:** D. Bailey has been studying economic factors that affect cattle, beef and water markets. Analysis of a small, integrated dairy operation demonstrate that on-farm anaerobic digesters for dairies of the size analyzed (200-head of dairy cows) could only be profitable if heavily subsidized by the local community or other funding sources. An analysis of investment decisions by so-called wealthy pastoralists in southern Ethiopia suggested that wealthy pastoralists continue to invest primarily in livestock assets, but that they plan to diversify more into non-livestock assets - primarily real estate and other investments in local towns and villages. The economic analysis of the data indicated, based on calculated risk-adjusted returns (Shaprpe's Ratio) that returns for livestock are high enough compared to relatively risk-free returns (bank accounts) to justify the continued investment in livestock even though they are a relatively risky asset.

**Research Impact:** J-S. Eun is investigating metabolic relationships in supply of nutrients for lactating cows. A continuous culture study was performed to investigate effects of virgin coconut oil (VCO) and condensed tannin extract from pine bark (PCT.) Supplementing PCT; and PCT and VCO in total mixed rations decreased ammonia-nitrogen concentration. VCO supplementation resulted in no effect on ammonia-nitrogen concentration.

Eun's group also did a total collection study to investigate nitrogen (N) excretions by dairy cows fed legume-based total mixed ration. Overall results in this study suggest that feeding birdsfoot trefoil hay in a dairy diet at a relatively high concentration (50% DM) did not affect overall lactational performance, whereas it shifted routes of N excretion evidenced by the decreased urinary-N:fecal-N ratio compared with feeding alfalfa hay. The positive impact on environment may be attributed to a functional effect of

condensed tannin as well as the unique cell wall structure of birdsfoot trefoil.

#### Sheep and Goats

**Research Impact:** I. Polejaeva has developed a transgenic large animal model for atrial fibrillation. Recently, it was found that the inflammatory response of atrial tissue in transgenic goats is primarily composed of CD68+ macrophages. This finding indicates an early inflammatory process, which can lay the foundation for progression of fibrosis. An exercise physiology study resulted in the novel observation that exercise in genetically engineered goats with an atrial fibrosis results in spontaneous atrial fibrillation. MicroRNA samples collected as part of this study are currently being analyzing.

**Research Impact:** N. Cockett is using genomic tools to identify genetic regions influencing traits in sheep. Lambs are sometimes born with a condition called entropion in which the lower eyelid is inverted, causing the bottom eyelashes to rub on the cornea which can lead to blindness if not treated. Samples from five paternal half-sibling families segregating for entropion were collected in 2014 and 2015. Forty eight of the 159 lambs produced by these five paternal half-sibling families were born with entropion. In an attempt to identify genetic regions involved with the entropion eye condition, genomic DNA was extracted from all lambs, sires and dams in the five families and the DNA samples genotyped with the Illumina HD SNP chip. Analysis of the SNP genotypes and entropion was done using SNP & Variation Suite v8. (Golden Helix, Inc.). Preliminary results suggested associations between the entropion condition and SNP markers on ovine chromosomes 1 and 3.

**Research Impact:** N. Cockett and her collaborators on multistate project NRSP8 have initiated a new ovine genomics project based on guidelines designed by FAANG (Functional Annotation of Animal genomes.) The Ovine FAANG Project has been awarded a 2016 NIFA/AFRI grant (B. Murdoch PD) and will contribute to the core activities of FAANG by providing transcriptome data and detailed annotation of genes and regulatory features in the sheep. An important milestone for the Ovine FAANG Project occurred in April 2016, when members of ISGC research group as well as personnel from the Department of Animal, Dairy and Veterinary Sciences at Utah State University collected 100 tissues from Benz 2616. Tissue samples were either snap frozen in liquid nitrogen and can be used for assays such as RNA-seq and ChIP-seq, or slowly frozen or processed into DNA that can be used in chromatin accessibility assays. Additionally, formalin fixed paraffin embedded (FFPE) tissues were processed for histological examination from approximately sixty locations representative of all major body systems. All transcriptome and regulatory data generated in the Ovine FAANG Project will directly connect to the de novo reference genome sequence generated from Benz 2616.

**Research Impact:** J. Hall is conducting toxicological evaluation of metals and plants as they apply to livestock. A study was undertaken to determine the male reproductive toxicity and effects of plant derived excessive dietary selenium and estimate the risks posed to human and animal health. High selenium containing plant material was harvested, dried, ground, analyzed, and incorporated into feed pellets at 0.25 (control) and 25 ppm for the dosing yearling rams. Twenty yearling rams had semen evaluations performed pre-study and were then divided into 10 control and 10 treatment animals. These rams received the study diet for 8 weeks. At the 4-week semen evaluation, a majority of the rams on the 25 ppm selenium diet had poor semen quality, with low percentage motility and high percentage abnormal sperm. These abnormalities were more severe at the 8-week time period less than 30% motility and greater than 70% sperm abnormalities (looped tails, tail-less heads, and proximal droplets). At 8 weeks, the high selenium diet was removed. Semen evaluation was performed at 4 and 8 weeks after removal of the high selenium diet. Semen evaluation returned to control animal values.

**Success Story:** Cash receipts from livestock enterprises in Uintah and Daggett Counties are around \$25 million annually. Cash receipts from crop enterprises reach \$12 million annually. Producers seek information on livestock rations and nutrition, risk management, livestock health, crop variety selection, hay testing and marketing and other subjects. The Wool Pool offers small sheep producers the opportunity to sell their wool. Other major programs cover agricultural production needs in the areas of irrigation, soils and pest control. Producers received \$2,902 for wool that would probably have been hauled to the landfill without the wool pool and they gained knowledge and skills to improve profitability.

#### Horses

**Research Impact:** R. Mayer is studying sperm chromatin composition and the fertility of domestic animals.

The fertility of male breeding animals is an important issue with economic and practical aspects. In animal production, relatively few males are used for breeding purposes because they are more difficult to manage than females and they mostly serve only the purpose of producing quality offspring. The results in stallion suggest that H4K5, H4K8 or H4K12 acetylation are not key events triggering the histone-to-protamine transition, but H4K16 acetylation is. This is an exciting new step towards understanding sperm epigenetic programming and chromatin integrity. In summary, the data suggest that the stallion may be an overlooked model for male fertility research related to nutrition, environmental toxicology and aging.

#### Poultry

**Research Impact:** R. Coulombe is studying ways to use diagnostics to enhance disease resistance in poultry. This year, research focused on determining the relationship between phenotype (relative aflatoxin resistance; hepatic GST enzyme activity) and genotype (DNA/RNA sequencing of GST-related gene products) in agriculturally-important avian species. Variables were compared in three breeds of chickens (broilers, Leghorns, Fayoumi) quails (Hawaiian and Japanese varieties), domesticated turkeys (the most disease susceptible) and wild turkeys (relatively resistant). After broad-scale biochemical enzyme activity analyses, the data indicates that Japanese and Hawaiian quail varieties have significantly higher protective hepatic GST activities, but lower than that of the three chicken breeds. Compared to chickens, quail have a greater cytochrome P450-mediated biotransformation rate ( $V_{max}$ ) and a greater affinity (lower  $K_m$ ) showing that rates of hepatic AFB bioactivation to the toxic and carcinogenic AFB-8,9-epoxide are much higher in quail than in chicken, lower than that in domesticated turkeys.

**Research Impact:** J. Hall is conducting toxicological evaluation of metals and plants as they apply to livestock. A study was conducted to identify the relative risks of different chemical forms of pyrrolyzidine alkaloids in an avian model. The comfrey extract, a commonly used DHPA containing herb, was more toxic than pure lycopsamine or intermedine, indicating either an interactive effect or an effect of other compounds within the extract.

#### **CLIMATE CHANGE AND NATURAL RESOURCE USE**

##### Climate Change

**Research Impact:** R. Gillies and S.Y. Wang have developed a new El Nino-Southern Oscillation (ENSO) index for Utah and surrounding states. Their operational Climate Forecasting System (CFS) provides 1-to-3-month climate forecasts. Operational forecast product releases are being provided through the Utah Climate Center website and media outlets, (e.g., KUER). Updates of long-range forecasts that are now in operation include a 5-year Great Salt Lake level prediction that reflects Utah's drought situation; 30-day prediction for first fall freeze; and 30-day forecast for climate extreme events such as heat waves and high rainfall. The main audience for these forecasts is the farming community. The forecast of first freeze this year was accurate (within one week) and it has contributed to obtaining better pricing options for farmers, increasing competitiveness on the market. The study pinpoints the 'route' or pathway in which global warming impacts weather patterns in the western U.S. and this provides climate forecasters a tool (or hint) to track impending changes of seasonal climate.

**Research Impact:** L. Hipps has revealed connections between ocean-atmosphere conditions and drought in California. Hipps and colleagues found evidence of drought occurrence not related to the El Nino-Southern Oscillation (ENSO), and showed while the Pacific North American (PNA) and North Pacific Oscillation (NPO) do not directly cause drought in California, the relationships between them and with the upper air circulation pattern do modulate the spatial drought pattern in CA.

They have also been studying evapotranspiration (ET) of vineyards, and the utility of using remote sensing information to help growers schedule irrigations. They are using eddy covariance estimates of ET at three agricultural fields sites used to irrigate with saline waste water from a power plant. The data are combined with soil moisture and precipitation to determine the water balance, and ensure that saline water does not reach the groundwater.

**Research Impact:** S.Y. Wang is building high-density, long-range hydroclimate resource information from Forest Service survey data. He analyzed tree-ring sensitivity and physiological response to the different climatic, geographical and hydrologic conditions for individual species and determined their optimal combination in depicting hydrological variations. Ring width frequently underestimates extremely wet years, a phenomenon referred to as 'wet bias'. His work takes into account wet bias by introducing two

modified linear regression models: a linear spline regression (LSR) and a likelihood-based), in comparison with a quadratic regression (QR) model. Using gridded precipitation data and tree-ring indices of multiple species from various sites in Utah, both linear spline regression and wet bias adjusted linear regression (WBALR) show a significant improvement over the linear regression model and out-perform quadratic regression. This further shows that the wet bias emerges from nonlinearity of tree-ring chronologies in reconstructing precipitation.

#### Water Conservation

**Research Impact:** K. Kopp is studying the impact of water and nutrient conservation on sustainable urban landscapes. One study compared three climate-based irrigation controllers for both water application amounts and related plant health and quality. Significant differences in volumetric soil water content were observed, with the control tending to have higher values than the climate-based controllers. Turfgrass quality and health were negatively impacted using climate-based controllers, but not to a degree that would prevent their use. All of the climate-based controllers tested saved water when compared to the control treatment.

**Research Impact:** B. Yang is investigating land-use planning for farmland and water resource protection in Utah's Wasatch Front urban-rural gradient. Green infrastructure design at the Daybreak community has demonstrated performance benefits of reduced development impacts on storm water runoff and water quality, compared with the conventional community development approach.

**Research Impact:** S. Li is studying water-related agricultural land use in Utah's urban edge. Analysis of new urban development has demonstrated that about 50% of the development occurred on agricultural land. Conversion from agricultural land to urban land was impacted by the spatial locations of the land. Most of the conversions happened at the edges of urban areas. During the process of agricultural land's conversion to urban development, irrigated agricultural land contributed a larger portion than non-irrigated agricultural land. Comparing across the four time periods identified in this study, there were more and more non-irrigated agricultural land areas converted to urban areas. However, the opposite is true for the irrigated agricultural land. In the 1980s, irrigated agricultural land was the major source of land that experienced the conversion. While in the late 2000s, non-irrigated agricultural land became the major land source of conversion.

**Research Impact:** S. Jones is striving to improve fundamental understanding of vadose zone physical properties and processes, and how they interact with other environmental and biogeochemical processes across various spatial and temporal scales. A recent study investigated the influence of Stone Content on Soil Water Retention. The influence of soil-containing stone fragments on bulk soil hydraulic properties was quantified by determining the water retention curve (WRC) of soil, stone and stone-soil mixtures with varied volumetric stone content. The stony soil water retention function was measured using the simplified evaporation method. An averaging scheme to describe the WRC of stony soil based on the individual WRC of the background and stone inclusion was in good agreement with the experimental data. The HYDRUS-3D model was employed to simulate the evaporation experiment used for the WRC measurements. The model simulations supported the basic assumptions of the proposed averaging scheme.

**Research Impact:** S. Jones is developing novel methods for quantifying fluid-phase concentration and fluxes in porous media using fluid-specific sensors and multi-function sensing approaches. A novel trapezoid model, termed OPTical TRapezoid Model (OPTRAM), based on the linear physical relationship between soil moisture and shortwave infrared transformed reflectance (STR) was developed. OPTRAM surface soil moisture estimates derived from Sentinel-2 and Landsat-8 observations for the Walnut Gulch and Little Washita watersheds were compared with ground measurements. Results indicate that the prediction accuracies of OPTRAM and the standard trapezoid model are comparable, with OPTRAM only requiring observations in the optical electromagnetic frequency domain. The volumetric moisture content estimation errors of both models were below 4% with local calibration and about 4-5% without calibration. Another advantage is that OPTRAM only requires a single universal parameterization for a given location, which is a significant advancement that opens a new avenue for remote sensing of soil moisture.

**Research Impact:** E. Edwards is looking at management and policy challenges in a water-scarce world. Statistical analysis of the entire western US indicates that post-1940, irrigation via groundwater



increases land value, crop value, and irrigated acreage more than irrigation via increases in large surface water projects via irrigation districts. Without this expanded ground and surface water access post 1940, \$19 billion less value in crops would have been produced in the West each year--15 percent of total US crop production. Study of outcome of water allocation institutions throughout the state of Utah suggests that an additional 1.7 million acre-feet of water is available via water conservation. The largest potential water savings, at the lowest cost, are in agriculture and outdoor residential water use, where more efficient application can maintain acreage of crops and lawns at current levels while dramatically reducing use.

**Success Story:** Utah residents with automatic irrigation systems over water their landscapes by 30%. Irrigation systems are often inefficient due to factors such as poor timing of application, and low distribution uniformity due to improper maintenance such as clogged, broken, improper or inconsistent sprinkler heads. These inefficiencies lead to over watering. Sprinkler system inefficiencies can easily be determined through simple water checks. Water checks provide the opportunity to promote water conservation by increasing homeowner awareness through education and resources. The goal of Cache County Cooperative Extension Water Check Program is to elicit positive behavioral change in irrigation practices of Cache County residents. Participants in the program receive a sprinkler system evaluation, a homeowner's report indicating system issues, and defining these issues, a suggested watering schedule, and a handout on proper lawn maintenance. Retrospective surveys indicate that over half of the participants immediately reduced their landscape water usage after receiving their water check. Surveys also indicate that due to the water check, participants are more able to identify maintenance issues in their irrigation systems, know to adjust their time clocks each month of the growing season, and had other positive behavioral changes in their irrigation practices.

#### Range Resources

**Research Impact:** C. Ransom has been studying integrated weed management in Utah and the Intermountain West. Weed management efforts have been improved for many invasive species in Utah as more effective herbicides and application timings have been identified by this project and adopted by practitioners. Research has identified effective treatments for controlling of Russian knapweed, medusahead, downy brome and invasive plant species including rush skeletonweed, elongated mustard, and teasel. It documented that approximately 65% of kochai populations throughout Utah exhibiting some level of resistance to sulfonylurea herbicide. This information has been used to educate practitioners on resistance management strategies and the importance of integrated approaches to management.

**Research Impact:** P. Jakus is studying benefits and costs of natural resources policies affecting ecosystem services on public and private lands. Analysis of public lands ownership was extended to publicly owned land harboring energy resources. Wages and wage growth were found to be higher in counties with greater fossil-fuel resources; wages and wage growth were larger in counties as the proportion of county land owned by the state increased relative to private land. Wages and growth in wages were also higher as federal ownership increased relative to private ownership, but not as much as state ownership. In 2016, the Utah Dept. of Agriculture and Food contracted for an assessment of the physical and economic consequences of wildfire in Utah. Key findings thus far are wildfire risk is closely associated with land characteristics that are more prevalent on federal land in Utah than on state-owned land, cattle inventory in five southern Utah counties is inversely related to wildfire burned acreage, and visitation at four of Utah's five national parks is negatively affected by wildfire burned acreage.

**Research Impact:** B. Bugbee has been studying the effects of spectral quality on plant growth. Despite decades of research, the effects of spectral quality on plant growth and development are not well understood. This year we reported the effects of eight blue and green light fractions at two photosynthetic photon fluxes (PPF; 200 and 500  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) on growth (dry mass), leaf expansion, stem and petiole elongation, and whole-plant net assimilation of seven diverse plant species. The treatments included cool, neutral, and warm white LEDs, and combinations of blue, green and/or red LEDs. At the higher PPF (500), increasing blue light reduced growth in tomato, cucumber, and pepper but there was no statistically significant effect on radish, soybean, lettuce or wheat. At the lower PPF (200), increasing blue light reduced growth only in tomato (41%). The effects of blue light on growth were mediated by changes in leaf area and radiation capture, with minimal effects on whole-plant net-assimilation. In contrast to the significant effects of blue light, increasing green light in increments from 0 to 30% had a relatively small

effect on growth, leaf area and net assimilation at either low or high PPF. Surprisingly, growth of three of the seven species was not reduced by a treatment with 93% green light compared to the broad spectrum treatments. Collectively, these results are consistent with a shade avoidance response associated with either low blue or high green light fractions.

**Research Impact:** J. Boettinger is investigating ways of facilitating semiarid land management in a changing environment. Conserving rare plants is important to biodiversity. Shrubby reed-mustard (SRM; *Schoenocrambe suffrutescens*), a shrub endemic to the Uinta Basin, faces habitat loss due to energy development of fossil fuels. Three models (soil properties, Landsat 5 Thematic Mapper spectral data and a Soil-Spectral Correlation model) were utilized to locate, identify, and check key soil properties at potential SRM habitat sites. As a stepwise system for locating potential SRM habitat, these models provide a tool for land managers to narrow potential habitat within the study area and facilitate and verify SRM habitat suitability. Land managers can determine where the probability of SRM presence prediction is high and focus conservation or revegetation efforts on these areas.

**Research Impact:** P. Johnson is evaluating turfgrasses for adaptation in the Western US, especially: Kentucky bluegrass, perennial ryegrass, tall fescue, bentgrasses, and other species with potential for tolerance to Intermountain West conditions. Special attention has continued on traits for drought tolerance that are necessary for sustainable management. Under conditions with infrequent traffic, bentgrasses were irrigated at 60% of ETo and produced quality similar to that at 80%. This constitutes an irrigation savings of up to 20% compared to typical recommendations. Also under conditions with infrequent traffic, tall fescue entries were irrigated at 50% of ETo and produced satisfactory quality. This represents an irrigation savings of 20-25% compared to typical recommendations.

**Research Impact:** G. Cardon is studying soil productivity management issues in Utah and the Western US. Major accomplishments for 2016 in soil fertility management includes the determination that much greater nitrogen credit can be given for a previous alfalfa crop to the subsequent production of silage corn in the first year of rotation and even in the second year of rotation. This result is very significant in that it is clearly possible to reduce the N requirement for first and second year corn after alfalfa up to 200 units of N per acre (based on typical grower practice and USU recommendations) without yield reduction. This is projected to potentially save Utah corn growers up to \$6-\$12 million annually (depending on the percentage of alfalfa ground in rotation). An apparatus was developed to measure orchard canopy light interception on the go to obtain maps of canopy structure and density that can be correlated to fertility management, soil type, age of trees, or other coincident data within an orchard. This data may affect productivity and grower management decisions.

**Success Story:** One way to reduce big game impacts to agricultural lands in Utah and to slow the conversion of agricultural lands to urbanization is to create an incentive-based program that rewards private landowners for providing wildlife habitat and allowing public hunting access. In 2016, the Cooperative Wildlife Management Unit program generated an additional \$45 million in new revenue for Utah landowners and provided free access to over 6,500 Utah hunters annually to high quality big game hunting opportunities. The program has now grown to incorporate over 2.5 million acres of private rangeland owners and managed by 115 operations. It includes over 500 landowners.

### **Sustainable Energy**

**Research Impact:** C. Hansen and C. Carpenter have been researching ways to improve profitability of farm scale anaerobic digestion. A 23,000 L hydrogen forming Induced Bed Reactor (IBR) tank was installed at the Logan lagoons (Logan city's wastewater treatment system) next to two 1000 gal (3,800 L) methane forming tanks. Significant amounts of hydrogen and methane were produced in experimental trials comingling food waste, algae and grass clippings to control pH during anaerobic digestion of low pH (3-4) food waste. Proving that these waste products can be successfully anaerobically digested and that prohibitively expensive pH control chemicals and control systems are not necessary, makes anaerobic digestion of these types of food wastes more economical.

The economics of installing small IBR anaerobic digesters on family sized dairies having food processing wastes available to add to the digester was studied. The addition of cheese whey was chosen for this project. Results of laboratory experiments in lab scale IBR digesters showed that mixtures of whey and manure (up to 100% of either) in the digester could be successfully digested in an IBR anaerobic digester

without addition of expensive pH control chemicals. Adopting anaerobic digestion for waste management on a family sized dairy farm with cheese whey available to add to the digester at no or negative cost was feasible if some subsidies for the investment were provided by the community, state or federal government.

## **CHILDHOOD OBESITY, NUTRITION, AND COMMUNITY SUSTAINABILITY**

### Childhood Obesity

**Research impact:** H. Wengreen has been working on a game-based approach to obesity prevention in children. The PI and her research team have continued to work on the narrative and gaming components of the FIT Game. Additional content was developed to lengthen the game from approximately 20 days to approximately 50 days. Gaming elements were added to model and encourage children to be more physically active in addition to eating more vegetables. The Research team worked with a professional artist to enhance the visual presentation of the game narrative. High quality game material is important as it should enhance the children's interest in the Game and thus promote further increases in vegetable consumption. Two schools were recruited to participate in a randomized trial testing the efficacy of the longer 50-day version of the game. The game was implemented in one school randomly assigned to implement the Fit Game. We assessed school-wide and individual level vegetable consumption at two periods among children in both the intervention (n=350) and control schools (n=250). In addition, school-level physical activity methods were assessed on 4 days at the intervention school.

### Nutrition

**Research Impact:** H. Wengreen studied incentivizing fruit and vegetable intake among children. The feasibility of implementing the full Food Dudes program in U.S. elementary schools as previously described within the U.K. school system was assessed. A cost analyses of the program determined that the program costs approximately \$12.50 per child to implement, which is likely a barrier of the program being adopted for use on a wide scale within the U.S. school system. In the pilot study, fruit and vegetable intake increased by nearly 100% during the 16-day intervention, and was attenuated but remained elevated (42% increase) over baseline after the 3-month follow-up period. In the intervention trial, children participating in the Food Dudes program had fruit and vegetable intakes that were 50-92% greater than the intakes of children in the control schools after the 16-week intervention, and intakes remained elevated (by 43-46%) at the end of 3-month follow-up period for both the tangible prize, and praise-only incentive conditions, but remained elevated for only the tangible prize group at the end of the 6-month follow-up period. In the Food Dudes program, we observed that while children in both the prize and praise groups increased fruit and vegetable consumption over the course of the study, that the prize group increased more, and in addition, that only the prize group maintained their higher fruit and vegetable consumption during the three and six-month follow-up assessments. Although the tangible rewards seemed important to the behavior outcome of interest in the Food Dudes studies, it was also the component of the program that introduced the biggest barrier to wider implementation.

**Research Impact:** R. Munger has been studying the relationship between maternal dietary patterns and the risk of oral cleft birth defects. Oral clefts occur at a higher rate in Utah than any other state and the reasons are unknown. Rates are also high in developing countries and we have expanded our studies to India. Our results have an important impact because they suggest that maternal multivitamin use alone is unlikely to reduce the risk of oral clefts -- a combination however of maternal folic acid supplementation, perhaps at a level above the usual 400 ug/day dose, and a healthy DASH dietary pattern with high intakes of fruits and vegetables, low-fat dairy products, reduced saturated fat and red meat intake, increased poultry and fish intake, and reduced intake of sweetened beverages and added sugars may reduce the risk by 50 percent

**Research Impact:** R. Munger is studying how gestational diabetes influences the risk of orofacial cleft birth defects, and fetal programming of obesity and diabetes mellitus in offspring. The results suggest that extremes of maternal pre-pregnancy weight are associated with risk of orofacial clefts, with obese mothers having an increased risk of all types of orofacial clefts while underweight mothers have a decreased risk of cleft lip only and an increased risk of cleft palate only. Maternal depression was also associated with orofacial cleft risk and merits further investigation. Both pre-existing and gestational diabetes were associated with orofacial cleft risk, with strongest effects for non-isolated orofacial clefts. Both stratification

and mediation analyses suggest an effect of obesity on orofacial clefts apart from known maternal diabetes. The growing epidemics of obesity and diabetes and the challenge of early detection and treatment of gestational diabetes mellitus underscore the public health importance of further research in this area.

**Research Impact:** K. Hintze is developing improved animal models for nutrition and chronic disease research. His work has resulted in several novel findings. Most notably, mice fed a diet formulated with a complex food matrix have a microbiome that is unique from mice fed purified diets. However, the food matrix did not alter response to inflammation driven colorectal cancer. This has resulted in a change of knowledge in terms of the physiological relevance of animal models.

**Research Impact:** R. Ward is studying the effects of heat-derived 'glycotoxins' on metabolic health. Mouse diets with different levels of carboxymethyllysine (CML) were created. A mouse feeding study was completed at the beginning of 2015, and it was determined that dietary CML affects several metabolic parameters, including fasting glucose and glucose tolerance. There were three major findings from this feeding study. First, CML appears to increase populations of the microbiome that are associated with gut dysbiosis. Next, the metabolites of the microbiome (i.e. short chain fatty acids) were significantly affected by the CML content of the diet. Last, dietary CML caused a dose-dependent increase in several plasma metabolites, all of which are associated with decreases in metabolic health.

**Research Impact:** K. Allen is evaluating native wild-growing berries as potential food antioxidants. Silver buffaloberries, River Hawthorne berries, and Skunkbush berries were located in Uintah County, UT, and harvested with the help of Extension faculty. Wild-growing chokecherries were also harvested to serve as a reference, as they have been more extensively studied and discussed in literature. The berries were held at -80 C to completely freeze, were freeze dried, and ground for testing. One portion was analyzed immediately for antioxidant content, while the remaining portions were packaged in vacuum-sealed bags and held at -20 C to determine the effectiveness of freezer storage on antioxidant content. The stored portions will be analyzed after 2, 4, and 6 months of storage. In the initial testing, Buffaloberries were found to be higher in carotenoids (3.5 +/- 0.3 mg/100g dry weight) than other berry species examined. River Hawthorne and Chokecherries were found to be higher in anthocyanins (1.3 +/- 0.1 and 1.5 +/- 0.1 mg/100g dry weight, respectively). Total antioxidant activity (taken as the sum of water soluble and lipid soluble fractions as determined by oxygen radical absorbance capacity) range between 250 and 350 umol/g dry weight Trolox equivalents, indicating all of the species show some potential as antioxidants

#### Community Sustainability

**Research Impact:** K. Christensen is studying the role rural environmental context plays in individuals with disabilities' health and well-being. Results of this study indicate that the physical activity of individuals with disabilities in rural versus urban environments is different, that the physical activity of individuals with disabilities in rural environments is different from that of individuals without disabilities in rural environments; and that the prevalence of chronic diseases associated with physical inactivity is different for individuals with disabilities in rural environments than for individuals without disabilities. For each of these differences, individuals with disabilities residing in rural environments are the least active and most at-risk for chronic disease.

#### Community Resource Planning and Development

**Success Story:** Manufacturing Extension Program. This program was developed to assist Utah's small manufacturers to learn and acquire new technologies and processes to help them become more competitive. The manufacturing sector plays a major role in Utah's economy. Small and medium sized manufacturers confront major problems in responding to increasing global competition. These problems encompass a broad range of issues, only some of which relate directly to technology. Inadequate resources - people, money, expertise, information, and insufficient time are reasons many small industrial firms are not improving their manufacturing performance. During 2016 (through 2 Quarters of NIST Surveys) in Utah 35 of 37 companies reported impacts including \$13,536,502 in increased sales and retained sales of \$50,455,002. Cost savings amounted to \$4,511,001. Total investment impact of MEP programming was \$44,012,312. There were 874 jobs created or retained through the efforts of MEP.

#### Individual and Family Resource Management

**Success Story:** During the 2016 tax season, taxpayers received Volunteer Income Tax Assistance via the

Virtual VITA delivery model and the support of their local Extension office. In total the filers received \$194,184 in federal and state refunds. It is estimated the taxpayers saved around \$40,000 in tax preparation fees. Partly due to training that USU extension has done for the IRS and other interested parties the concept has expanded on a national level. During the 2016 tax season about 30,000 returns were completed following the Virtual VITA model developed in Utah. If the benefits are similar to those seen in Utah it would mean that volunteers at these other locations helped qualifying taxpayers receive \$40 million in refunds.

#### Youth Development

**Success Story:** STEM programming has been implemented to help youth increase their science abilities and better prepare them to enter the workforce. Multiple efforts have been made to increase science opportunities for youth in the community through partnering with schools, community organizations and the local libraries. A before/after evaluation is completed, especially for those programs lasting at least six hours. Evaluations have consistently found that youth report they can "teach someone else about subject of the workshop," that "they want to learn more about science" and "think they are good at science," that they would "tell their friends to take the workshop" after attending science workshops. One impactful program is computer coding. Results of a before/after survey (based on 74 participants with average age 10; 33% girls and 66% boys) based on a Likert scale (1-5) found that there was an increase in the following statements: "Can create a game using computer programming skills" (3.22 before/ 4.29 after), "Feel like they know a lot about computer programming" (2.93 before/ 3.93 after), and "Could teach someone else about computer programming" (2.77 before/3.47 after). Gaining skills and confidence in technology programs such as this can potentially have great impact on career choices and success in the future.

**Success Story:** Through partnership with after-school programs in the urban areas of one county, 4-H clubs were implemented by after-school leaders in all of the YMCA after-school clubs (12 different sites) and at Club Heights Elementary. Through providing training, curriculum, and support for after-school site coordinators, urban youth that would otherwise not have 4-H experiences are able to participate in 4-H. An evaluation was completed by a partnering agency at one of these urban after-school sites to determine the impact of the program on youth. A staff assessment of the youth before and after the clubs indicated that youth increased in their social-emotional skills in eight areas (i.e. self-awareness, self-management, social awareness, relationship skills, personal responsibility, decision-making, goal-directed behavior, and optimistic thinking). This was especially true for the lowest skilled youth, yielding substantial overall impacts in their interaction with others. Additional evaluation from a combination of student self-report, classroom teachers and program staff indicated significant improvement in positive peer relations, program activities, work habits, and social skills. These social-emotional skills are the same life skills taught in 4-H that contribute to healthy youth development and help youth become caring and contributing members of society.

#### Nutrition Education and Behavior

**Success Story:** Pop-up farmers' markets at Salt Lake County senior centers. Approximately 15 percent of Utah seniors face the threat of hunger and over 50,000 seniors reported that they are currently struggling with hunger. Seniors comprise approximately 10% of Salt Lake County's total population (110,000 seniors in Salt Lake County). Source 2010 US Census. Produce was donated from the USU Extension managed Meals Plus Harvest Garden, Wheeler Farm, Green Urban Lunchbox (local not-for-profit) and Bell Organic (local urban farm). The pop-up senior center farmers' markets were a huge success with increasing numbers of seniors taking advantage of free produce with each passing week (average 39 seniors, range 18-100 seniors per event). The program serviced a total of 1,087 seniors in its pilot year. Master Gardener volunteers surveyed seniors after they selected produce at pop-up senior center farmers' markets. Documented examples of outcomes from the Meals Plus program include:

- 64% of recipients did not grow their own produce at home.
- 97% of recipients reported the program had a positive impact on them.
- 96% of recipients reported the produce helped them save money at the grocery store
- 85% reported the produce increased their consumption of fruits and vegetables, and

- 95% reported the produce contributed to a healthier diet.

**Success Story:** Utah residents experience poor health and nutrition, rising health care costs, increases in chronic disease, mental health incidents, and obesity rates, sedentary lifestyles, and additional unhealthy environmental factors. The Healthy Habits program enrolled community members to participate in three six-week challenges to assist them in acquiring healthy habits. Weekly health tips were emailed, three information classes were held, weekly tracking was reviewed, and pre and post health assessments were completed. Knowledge was gained about health and wellness topics, behavior was changed to reflect better daily habits, daily exercise and water intake increased, BMI decreased along with weight loss, perceived overall health improved, and better body strength and flexibility was developed.

## FOOD SAFETY

**Research Impact:** D. Wilson used on-farm surveys to characterize the detection and recording of diseases in dairy cows and calves. While in 2007 only 3% of U.S. dairy farms pasteurized waste milk for calves, after recommendations were distributed in 2012 regarding bacteria counts and pasteurization methods for calf milk, 34% of Utah dairy farms were pasteurizing calf milk during 2016. In 2013, the third statewide surveillance project retested all herds for mycoplasma and Johne's disease (JD), and tested for Bovine Viral Diarrhea (BVD) for the first time. Starting in 2009, an outreach and control program was offered to all dairy producers whose herds tested positive for any or all of the diseases. By 2013, only one (6%) of the 16 Utah dairy herds previously positive for mycoplasma remained positive. The proportion of Utah dairy herds positive for mycoplasma is now 3% (4 herds). The direct cost of new mycoplasma infections estimated to have been prevented by reducing or eliminating the population of cows already infected was \$1.48 million. Estimated increased milk production in herds eliminating or reducing mycoplasma resulted in additional savings of \$3.6 million. This is one of the lowest proportions ever reported in any region or state in the world. In 2013, 33% of previously JD-positive herds tested negative for the disease. In addition, the proportion of herds testing JD-positive after testing for the first time was twice as high (39%) as the proportion of herds that participated in the 2009 outreach and control program (20%). The estimated savings from elimination of existing JD and prevention of new infections in Utah dairy herds is \$1.5 million. The somatic cell count (SCC) is a white blood cell measurement in milk. A lower SCC is associated with less mastitis and improved milk quality in cows and herds. In 2015, Utah became one of a few states in the U.S. to have an average SCC in milk below 175,000/ml. Few herds have SCC greater than 250,000/ml today. This reflects the continuous improvement in Utah's excellent milk quality.

**Research Impact:** In an effort to reduce use of live animals in research, and to develop experimental models to study the molecular mechanisms of regulatory pathways of the universal detoxifying enzyme glutathione S-transferases, R. Coulombe and A. Benninghoff developed an avian embryo exposure model. Previous results demonstrated that domesticated turkeys (*Meleagris gallopavo*) are especially sensitive to aflatoxicosis, while Eastern wild turkeys (*M. g. silvestris*) are relatively resistant. In ovo exposure provided a controlled aflatoxin B1 (AFB1) challenge for comparison of domesticated and wild turkeys. AFB1 effects were dependent on exposure time and turkey type, occurred more rapidly in domesticated turkeys, and led to notable up-regulation in cell cycle regulators, NRF2-mediated response genes, and coagulation factors. Further investigation of NRF2-response genes may identify targets to improve poultry resistance.

**Research Impact:** V. Pozo is studying the effects of meat and poultry recalls on US stock markets. She quantified the impact of meat and poultry recalls on the stock prices of firms directly involved, and is determining how specific factors associated with meat and poultry recalls and the firms involved explain the magnitude of stock price reactions. On average, recalls caused by foodborne pathogens reduce firm value by 1.66 percent within 4 days following the recall, equivalent to \$133.8 million. Listeria type recalls are the most costly to firms, followed by those caused by Salmonella and Shiga toxin-producing *E. coli*. For the average firm in the sample, the reduction in firm's value 4 days after the outbreak is: \$265.5 million, \$90.8 million and \$61 million, corresponding to Listeria, Salmonella and *E. coli* recalls, respectively.

### Home and Commercial Food Service

**Success Story:** According to USDA food safety recommendations bacteria, yeasts and molds can grow in home-canned foods if not preserved properly. In addition, low-acid foods are at risk for clostridium

botulinum which can grow into the food-borne illness botulism. Food preservation and food safety education is taught in order to prevent food-borne illness, to protect the time and money investment that families put into preserving food, and to help preserve food to eliminate food waste. Evaluations of the Master Food Preserver Series measure both knowledge gain and intent to change food safety behaviors. Knowledge gained included where to look for safe canning resources changed from 23% above average or excellent knowledge to 92%. The change in knowledge of necessity of adjusting processing times/pounds of pressure for altitude went from 15% above average and excellent to 92%; liquid poured into a jar of fruit should always be hot 15% to 92% above average and excellent; most vegetables need to be blanched prior to dehydrating 14% to 79% above average and excellent; vent pressure canner for 10 minutes prior to building pressure 15% to 92% above average and excellent; add acid to tomato products 17% to 100% above average and excellent; and the need to process all jam and jelly products went from 30% to 90% above average and excellent.

**Total Actual Amount of professional FTEs/SYs for this State**

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	110.0	0.0	65.0	0.0
Actual	91.9	0.0	44.1	0.0

**II. Merit Review Process**

**1. The Merit Review Process that was Employed for this year**

- Internal University Panel
- External University Panel
- Combined External and Internal University Panel
- Expert Peer Review

**2. Brief Explanation**

Agricultural Experiment Station: The scientific peer-reviewed process within the agricultural experiment station involves two steps. Prior to submission to the experiment station, the PI's department head reviews and signs off on the proposal. Once the proposal reaches the station, two scientific peer reviews are obtained from subject matter experts, either from other on-campus faculty (if the expertise exists) or off-campus faculty (if on-campus expertise does not exist). If there is a conflict between these two reviews, an additional peer review is sought. These anonymous external reviews are returned to the experiment station and the PI's are asked to respond to issues raised by these reviewers. The PI then modifies her/his proposal to address the issues raised by the "outside" reviewers before resubmitting it to the experiment station for funding consideration. The practice of sending reviews off-campus to qualified subject matter experts is used approximately 10%-15% of the time.

Utah Cooperative Extension Service: The cooperative extension service merit review process involves a review by the University of Wyoming, University of Arizona, and the University of New Mexico extension services. These institutions will review the program components suggested in each program area utilizing extension faculty qualified as specialists with significant program experience in the area being reviewed. In turn, Utah State University Cooperative Extension Service will review the work from these three institutions.

### **III. Stakeholder Input**

#### **1. Actions taken to seek stakeholder input that encouraged their participation**

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public

#### **Brief explanation.**

Media sources are frequently used by Utah counties to encourage county residents to participate in public meetings and listening sessions. Use of local newspaper and radio resources through public service announcements and paid advertisements are the two primary techniques applied in media use. Counties target traditional stakeholders through letter/poster invitations to participate in public meetings and listening sessions. Such announcements are often placed in public places, on bulletin boards, and other locales frequented by traditional audiences. Non-traditional stakeholder groups are also specifically invited to participate in public meetings and listening sessions through various public and private invitations. Inviting individual stakeholder and non-traditional stakeholder individuals to participate in public meetings and listening sessions is also a significant means of engaging them in discussions. Surveys serve as another means for contacting stakeholders, traditional and nontraditional. For the experiment station, research scientists, often with an extension appointment, work with extension leaders to ensure that ample stakeholder participation is achieved. Even faculty with primary research appointments and strong industry affiliations often provide a unique perspective about different audiences that should be cultivated or developed. Advisory groups, both at the county and university levels, are utilized in obtaining stakeholder input.

#### **2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them**

##### **1. Method to identify individuals and groups**

- Use Advisory Committees
- Use Internal Focus Groups
- Open Listening Sessions
- Use Surveys

#### **Brief explanation.**

The Utah Agricultural Experiment Station used many of the same advisory groups used by Extension that meet as needed to provide critical input from public and private sectors. Listening groups with key constituents were also utilized. Utah Extension utilized advisory committees as the primary means of identifying stakeholder individuals and groups to collect program input. Council and advisory groups utilized groups, such as teen councils, horse and livestock councils, Workforce Services, Inter-agency Coalitions, community religious leaders, United Way, Utah State Advisory



Boards, Utah Fair Boards, Utah Farm Bureau and Farmers Union Boards, after-school coalitions and previous recipients of Extension programs were also utilized. Counties used focus groups and open listening sessions as means to identify group and individual stakeholders. Needs assessments and surveys provided another primary means of identifying individuals and groups.

**2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

**1. Methods for collecting Stakeholder Input**

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

**Brief explanation.**

Input received from stakeholders has been utilized to redirect Experiment Station and Extension programs, to gather information on emerging issues, and to set priorities as a unified Extension and Experiment Station organization. With an ever growing Metro population along the Wasatch front in Utah, this input has been valuable in redirecting Extension and Experiment Station program emphasis areas to reflect the needs of Metropolitan populations. These inputs frequently inform Extension by influencing recruitment and hiring practices and the informing Extension on the types of applied research stakeholders perceive as critical to their need. The Experiment Station uses stakeholder input provided by Extension and advisory groups to change its research programs. As evidenced by existing and past hiring patterns, the Experiment Station has been changing program emphasis as open positions allow and/or through newly funded positions. Operating and graduate student funds go with those newly funded faculty positions.

**3. A statement of how the input will be considered**

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

**Brief explanation.**

The input received from stakeholders was utilized to redirect Experiment Station and Extension programs, to gather information on emerging issues, and to set priorities as a unified Extension and Experiment Station organization. With an ever growing metro population along the Wasatch Front in Utah this input has been valuable in redirecting Extension and Experiment Station program

emphasis areas to reflect the needs of metropolitan populations. These inputs informed Extension through influencing recruitment and hiring practices and on the types of research that stakeholders perceive as critical to their need. The Experiment station used stakeholder input provided by Extension and advisory groups' input to make changes in the research program through alternative funding measures and new faculty hiring. The Experiment Station has been changing program emphasis as open positions allow and/or through newly funded positions. With those funded positions go operating and graduate student funds.

**Brief Explanation of what you learned from your Stakeholders**

Most stakeholders are still tied to specific program areas although they are interested in all programs offered through USU Extension and the Experiment Station. Information related to home horticulture and organic gardening for food production are important to the general public.

Agricultural sustainability, including marketing, weed control, crop management and animal health issues, are important to agricultural producers and these areas are supported by both the Experiment Station and Extension. Production and marketing issues are still critical to agricultural producers and require both Extension and the Experiment Station resources. The economics of various new technologies or production techniques continue to be important research topics for the Experiment Station and Extension. Basic home making skills including food preservation/preparation, food safety, nutrition and sewing are important to home makers and are supported extensively by Extension and, to a lesser extent, the Experiment Station. Families and individuals are in need of food and finance programming which require both Extension and Experiment Station input. Youth leadership development and continuation of traditional 4-H programs such as livestock, horse, sewing, cooking and others are important and stakeholders want to make sure these programs stay alive and viable and are supported primarily through Extension.

Most users of USU soil testing service and climate information value these services and want them to continue. The Experiment Station is involved in a host of research issues related to natural resources and the environment including climate change, public lands, water resources, urbanization of productive farmland, etc. -- all areas of critical importance to the citizens of the state of Utah. We have discovered that the public makes little, if any, distinction between Extension and the Experiment Station and likes USU to be available to help with a wide range of issues. Individual members of the public are always concerned as to why their important issues are not the highest priority with Extension and the Experiment Station, not realizing that there are inadequate resources to support all needed help. As a system, we understand that we cannot be all things to all people.

**IV. Expenditure Summary**

<b>1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)</b>			
<b>Extension</b>		<b>Research</b>	
<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
1758422	0	2335087	0

<b>2. Totaled Actual dollars from Planned Programs Inputs</b>				
	<b>Extension</b>		<b>Research</b>	
	<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
<b>Actual Formula</b>	1758422	0	1339598	0
<b>Actual Matching</b>	1758422	0	1339598	0
<b>Actual All Other</b>	0	0	12663477	0
<b>Total Actual Expended</b>	3516844	0	15342673	0

<b>3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous</b>				
<b>Carryover</b>	0	0	0	0

**V. Planned Program Table of Content**

S. No.	PROGRAM NAME
1	Global Food Security and Hunger
2	Climate Change and Natural Resource Use
3	Sustainable Energy
4	Childhood Obesity, Nutrition and Community
5	Food Safety

**V(A). Planned Program (Summary)**

**Program # 1**

**1. Name of the Planned Program**

Global Food Security and Hunger

Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		2%	
202	Plant Genetic Resources	0%		6%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		6%	
205	Plant Management Systems	55%		17%	
211	Insects, Mites, and Other Arthropods Affecting Plants	4%		12%	
213	Weeds Affecting Plants	6%		0%	
215	Biological Control of Pests Affecting Plants	0%		6%	
216	Integrated Pest Management Systems	9%		2%	
301	Reproductive Performance of Animals	0%		17%	
302	Nutrient Utilization in Animals	0%		6%	
304	Animal Genome	0%		12%	
307	Animal Management Systems	26%		6%	
603	Market Economics	0%		8%	
	<b>Total</b>	100%		100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	44.0	0.0	13.0	0.0
<b>Actual Paid</b>	23.4	0.0	20.5	0.0
<b>Actual Volunteer</b>	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
447737	0	760830	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
447737	0	760830	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	6532664	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

1. Conduct research experiments with livestock and plants and plant material.
2. Publish studies and make presentations related to plant propagation and livestock reproduction and plant and livestock production.
3. Conduct workshops and meetings to educate local, state, and regional stakeholders concerning progress in producing livestock and plants that are economically viable and environmentally friendly.
4. Provide new methods of livestock pest control and disease prevention.
5. Release new plant varieties relative to this program area under plant variety protection (PVP) status.
6. Expand use of Integrated Pest Management (IPM).
7. Provide pest diagnostic assistance and management information to county agents, state and federal partners, commercial agriculture and horticulture producers, and the general public through the Utah Plant Pest Diagnostic Laboratory.
8. Coordinate efforts with other states and the Western Region Pest Management Center (WRPMC).
9. Enhance the USU Master and 4-H Junior Master Gardener Programs.
10. Utilize multiple demonstrations/applied research plots to manage weeds in agronomic crops with results reported at field days, workshops, or annual meetings.
11. Conduct research experiments and develop theories that can be used to enhance plant and animal productive efficiencies through the use of genomics.
12. Publish studies related to these areas of concern.
13. Conduct workshops and meetings for other scientists involved in this area of research.
14. Develop applications for the research on plant and animal genomics to directly benefit producers and other scientists.
15. Conduct market tests to determine the price premium associated with alternative production and marketing programs.
16. Build models to quantify the impacts associated with international trade.
17. Develop risk reduction models for agricultural producers.
18. Analyze firm-level decisions to identify specific changes that might be made on individual farms and ranches that would enhance net returns.
19. Provide outreach to agriculture businesses, small manufacturers, and entrepreneurs to provide educational training and in-depth information on: small business management, home-based businesses, main street community programs, business retention and expansion, rural and heritage tourism, rural and economic development activities, E-commerce programs, community entrepreneurship, marketing (market feasibility, research, customer relations/service, pricing), finances (recordkeeping, raising capital, growing/expanding financial issues), business plans for potential business owners, patents/trademarks/copyrights, insurance, zoning, and legal requirements, identification of business

opportunities, and youth entrepreneurship programs.

**2. Brief description of the target audience**

The target audience for this work would be other scientists, agricultural producers, general public, home owners, green industry officials, professional landscape managers, turfgrass sod producers, local and regional livestock (primarily beef, dairy and equine) producers, small acreage owners, veterinarians, USDA, other private businesses, and government entities that conduct work in this area.

**3. How was eXtension used?**

Paul Hill is serving as the Associate Director of eXtension's Innovation Lab. In this role he reviews and selects 4 fellows from a nationwide pool of applicants to work on innovative projects that benefit the entire Cooperative Extension System. The Innovation lab built a network of 235 members from every state (and even Australia) that actively engage over social media to provide specific support in helping all Extension professionals use technology in concert with their program outreach goals. The lab is facilitated by members of the existing EdTechLN and various Innovation Partners including eXtension Fellows, Innovation Fund grant recipients, and user community leaders and members.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	80735	175205	36186	78528

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2016  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2016	Extension	Research	Total
<b>Actual</b>	0	80	80

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- {No Data Entered}



**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of clientele who gain knowledge about improved human, plant, and animal management systems.
2	Number of clientele who implement improved human, plant, and animal management systems.

**Outcome #1**

**1. Outcome Measures**

Number of clientele who gain knowledge about improved human, plant, and animal management systems.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

Year	Actual
2016	30925

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Cattle, livestock and forage production is important economically for rural counties. Due to increased regulations and reductions of livestock animal units (AU) on public ranges, and the high potential for drought, livestock producers must develop methods and select plant species which produce high quantities of low cost forage. Increasing forage quantities will help maintain the livestock industry. Cutting costs is critical for sustainable beef and forage producing operations. The beef industry needs to be educated about its products and learn how to market their commodities better.

**What has been done**

Three hundred and forty-seven people who manage 4,200 head of beef cattle attended Range Livestock Workshops (RLW).

**Results**

Ninety-four percent of the RLW attendees indicated the overall quality of the workshop to be excellent or higher, 92% stated that the workshop provided new skills, 85% modified their opinion and/or attitudes, and all participants said they will improve their advice they will give to others as a result of attending the RLW.

**4. Associated Knowledge Areas**

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
304	Animal Genome
307	Animal Management Systems
603	Market Economics

**Outcome #2**

**1. Outcome Measures**

Number of clientele who implement improved human, plant, and animal management systems.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

Year	Actual
2016	9199

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Threats to field crops include; unpredictable weather, water quantity, erratic hay prices, soil fertility, fertilizers practices, changing markets, insect and weed pest management and regulations, pests reducing yield and quality, etc. New varieties of alfalfa, small grains, safflower and corn need to be researched under Utah growing conditions. Also, cultural practices and weed control that improve production in existing fields need to be implemented to obtain maximum productivity.

**What has been done**

Data collected from local crop Research Plots continues to be a major interest to local, state, regional and national growers. Mike Pace, Dr Earl Creech and Clark Israelsen have presented often, and in four states, regarding the work they have been doing with oilseed crops, especially

safflower. They have had successful crop field days and cooperated with specialists in crop research projects.

### Results

Mountain States Oilseeds contracts 20,000 acres of safflower annually from Northern Utah and Southern Idaho growers. Three years ago the majority of the safflower raised was S-208 or CW 990L varieties. Today, because of USU safflower variety trials, 98% of their contracted safflower is S-333 which demonstrated yields 26 pounds per acre more than S-208. The color scores are superior and percent oil is higher thus making S-333 worth approximately 6 cents more per pound. This resulted in \$31,200 more that growers are making by planting a safflower variety that has been tested under Utah growing conditions.

## 4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
304	Animal Genome
307	Animal Management Systems
603	Market Economics

## V(H). Planned Program (External Factors)

### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### Brief Explanation

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

What has been done

Three hundred and forty-seven people who manage 4,200 head of beef cattle attended Range Livestock Workshops (RLW).

Results

Ninety-four percent of the RLW attendees indicated the overall quality of the workshop to be excellent or higher, 92% stated that the workshop provided new skills, 85% modified their opinion and/or attitudes, and all participants said they will improve their advice they will give to others as a result of attending the RLW.

### **Key Items of Evaluation**

**V(A). Planned Program (Summary)**

**Program # 2**

**1. Name of the Planned Program**

Climate Change and Natural Resource Use

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	3%		34%	
112	Watershed Protection and Management	21%		4%	
121	Management of Range Resources	14%		17%	
123	Management and Sustainability of Forest Resources	3%		9%	
132	Weather and Climate	0%		13%	
135	Aquatic and Terrestrial Wildlife	24%		4%	
205	Plant Management Systems	14%		2%	
213	Weeds Affecting Plants	7%		4%	
307	Animal Management Systems	0%		2%	
605	Natural Resource and Environmental Economics	14%		11%	
	<b>Total</b>	100%		100%	

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Year: 2016	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	12.0	0.0	13.0	0.0
<b>Actual Paid</b>	12.4	0.0	14.9	0.0
<b>Actual Volunteer</b>	0.0	0.0	0.0	0.0

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
237263	0	244738	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
237263	0	244738	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	4498119	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

1. Continue to facilitate and assist the establishment and success of local Conservation Resource Management (CRM) groups, for more local control of decisions on natural resources.
2. Educate the public with respect to the principle causes of air pollution and their role in prevention.
3. Partner with others to enable agriculture producers to meet EPA requirements.
4. Establish herbicide demonstration/research plots to evaluate the efficacy of these products under local conditions.
5. Conduct projects consultations, and workshops focusing on the role of outdoor recreation and natural resource-based tourism in relation to community development.
6. Partner with others in education and use of resources to rehabilitate the sagebrush steppe environment.
7. Educate and partner to enable the recovery of the sage grouse, pygmy rabbit and others to avoid listing as endangered species.
8. Determine management options that slow or stop the cycle of cheatgrass and fire on previously burned areas through range rehabilitation, seeding programs and nontraditional approaches to grazing management.
9. Educate producers and agency personnel on the need for continued range evaluation, monitoring, and management improvements and the role of grazing management in sustainable resource management.
10. Educate the public on responsible use and the value of multiple uses on rangelands.
11. Illustrate the need for management and control of pinion-juniper forests to restore watershed, wildlife habitat and forage values on rangelands.
12. Educate the public regarding various options with respect to adapting to global climate change
13. Provide information to landowners and users on grazing management of grazeable lands.
14. Partner with and educate the general public, livestock producers and agency personnel on the identification and methods of control of the specific noxious and invasive species.
15. Conduct experiments and develop theories that can be used to enhance water, soil, wildlife, and for various agronomic and urban areas.
16. Publish studies relating to this program area.
17. Provide educational training, problem solving, and in-depth applied information to: facilitate rehabilitation of degraded watersheds, protect and manage watersheds, conserving, managing and enhancing efficient water use, derive efficient irrigation strategies and technologies, implement water-wise landscaping practices, evaluate and promote plants that require less water and are drought tolerant, preserve and enhance water quality, enhance quality, capture, and use of storm-water and gray-water, identify areas of current or potential soil loss or reduced soil fertility and partner with other agencies to reduce and control these problems, educate producers on the important interactions of soil and irrigation,

provide information on soil nutrient deficiencies and cost effective soil quality and fertility improvements, continue demonstration projects - salinity, soil types, non-traditional soil fertility amendments, fertilizer formulation efficacy, organic matter use and management.

**2. Brief description of the target audience**

The target audience includes the general public, users of various environments (agricultural producers, extractive industry representatives, environmentalists, green industry professionals, etc.), small acreage owners, private forest owners, extension agriculture and horticulture agents, federal and state water and soil management agencies, and other academics and resource managers.

**3. How was eXtension used?**

Rhonda Miller is involved with the eXtension Animal Manure Management Community of Practice and is part of the planning committee for the 2017 Waste-to-worth conference.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	10790	1106986	5200	533487

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2016  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2016	Extension	Research	Total
Actual	0	80	80

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- {No Data Entered}





**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of clientele who gain knowledge about improved human, plant, and animal management systems that relate to climate change and/or natural resource use.
2	Number of clientele who implement improved human, plant, and animal management systems as related to climate change and/or natural resource use.

**Outcome #1**

**1. Outcome Measures**

Number of clientele who gain knowledge about improved human, plant, and animal management systems that relate to climate change and/or natural resource use.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

Year	Actual
2016	9766

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Much of the high quality wildlife-related recreation is associated with privately-owned lands. In the U.S., 2.1 million farmers and ranchers control more than 60 percent of the land base. As such, public wildlife inhabits, and is dependent upon, the habitat resources found on private land. Public and private wildlife management agencies and organizations have implemented programs to encourage landowners and other stakeholders to manage for wildlife and/or allow public hunting or recreational access. Lack of coordination between management agencies and stakeholder concerns about damage caused by wildlife and wildlife users have reduced the overall effectiveness of wildlife management.

**What has been done**

To address these issues in Utah, USU Extension facilitated the establishment of the Cooperative Wildlife Management Program Unit (CWMU) and a business association to address the needs of participants. The Association consists of over 200 farm and ranch operations encompassing over 2.0 million acres of private rangeland in Utah. Currently about 70% of all registered CWMU's in Utah are a member of the Association. We provide members with information, education, technical support, and policy guidance to enhance wildlife management, recreational opportunities, and alternate income potentials on private land.

**Results**

In 2016, the Cooperative Wildlife Management Unit program generated an additional \$45 million in new revenue for Utah landowners and provided free access to over 6,500 Utah hunters annually to high quality big game hunting opportunities. The program has now grown to incorporate over 2.5 million acres of private rangeland owners and managed by 115 operations. It

includes over 500 landowners.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
132	Weather and Climate
205	Plant Management Systems
213	Weeds Affecting Plants
307	Animal Management Systems
605	Natural Resource and Environmental Economics

**Outcome #2**

**1. Outcome Measures**

Number of clientele who implement improved human, plant, and animal management systems as related to climate change and/or natural resource use.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	7306

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Increased understanding of soil fertility and salinity helps farmers to efficiently use commercial fertilizers and manure resources to improve crop production, maximize profits and minimize nutrient pollution. Few farmers test soils for nutrient needs. Most use a mix of nutrients designed for the "average" field

**What has been done**

An USU Extension agent encouraged soil testing and helped participants interpreted the research based recommendations. In one County, thirteen farmers participated, testing 53 fields totaling 1,610 acres.

**Results**

Farmers saved \$53.00 per acre on average by soil testing and not purchasing unneeded nutrients for a total savings of \$85,330. By not applying an average of 50 pounds of unneeded nutrients per acre, 51 tons of unnecessary nutrients were kept out of the environment.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
132	Weather and Climate
205	Plant Management Systems
213	Weeds Affecting Plants
307	Animal Management Systems
605	Natural Resource and Environmental Economics

**V(H). Planned Program (External Factors)**

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

**Brief Explanation**

The Cooperative Wildlife Management Unit program generated an additional \$40 million in new revenue for Utah landowners and provided free access to over 6,000 Utah hunters annually to high quality big game hunting opportunities. The program has now grown to incorporate over 2.5 million acres of private rangeland owners and managed by 110 operations. It includes over 500 landowners.

**V(I). Planned Program (Evaluation Studies)**

**Evaluation Results**

The Cooperative Wildlife Management Unit program generated an additional \$45 million in new revenue for Utah landowners and provided free access to over 6,500 Utah hunters annually to high quality big game hunting opportunities. The program has now grown to incorporate over 2.5 million acres of private rangeland owners and managed by 115 operations. It includes over 500 landowners.

**Key Items of Evaluation**

The Cooperative Wildlife Management Unit program generated an additional \$45 million in new revenue for Utah landowners and provided free access to over 6,500 Utah hunters annually to high quality big game hunting opportunities. The program has now grown to incorporate over 2.5 million acres of private rangeland owners and managed by 115 operations. It includes over 500 landowners.

**V(A). Planned Program (Summary)**

**Program # 3**

**1. Name of the Planned Program**

Sustainable Energy

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
402	Engineering Systems and Equipment	67%		0%	
403	Waste Disposal, Recycling, and Reuse	33%		0%	
502	New and Improved Food Products	0%		50%	
511	New and Improved Non-Food Products and Processes	0%		50%	
<b>Total</b>		100%		100%	

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Year: 2016	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	1.0	0.0	0.4	0.0
<b>Actual Paid</b>	0.6	0.0	0.0	0.0
<b>Actual Volunteer</b>	0.0	0.0	0.0	0.0

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
11480	0	0	0
<b>1862 Matching</b>	<b>1890 Matching</b>	<b>1862 Matching</b>	<b>1890 Matching</b>
11480	0	0	0
<b>1862 All Other</b>	<b>1890 All Other</b>	<b>1862 All Other</b>	<b>1890 All Other</b>
0	0	68502	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

1. Conduct research into alternative biofuels and methods of production that are well-suited for the Intermountain West.
2. Publish in peer-reviewed journals and other professional outlets.
3. Take the research that is done and adapt that research so useful practical strategies might be followed in producer biofuels to the extent that it can be shown to be beneficial in terms of benefits and costs.

**2. Brief description of the target audience**

For experiment station faculty their target audiences are primarily directed towards extension specialists, county agents, and other scientists; the extension specialists' audiences include peers, county agents, federal and state organizations, producer groups, state and local government, and the general public. County agents work cooperatively with federal, state, and local governments, citizen groups, and the public to address sustainable energy issues in their areas.

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	262	340	53	69

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2016  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2016	Extension	Research	Total
<b>Actual</b>	0	6	6

**V(F). State Defined Outputs**

**Output Target**



**Output #1**

**Output Measure**

- {No Data Entered}

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of clientele gaining sustainable energy knowledge
2	Number of clientele who implement sustainable energy practices

## **Outcome #1**

### **1. Outcome Measures**

Number of clientele gaining sustainable energy knowledge

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	340

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Utah's commercial tree fruit industry is threatened by rapid urban expansion which results in diminished land and water resources. To remain competitive, Utah fruit growers need to: diversify into new crops, explore new marketing opportunities, and adopt more efficient management strategies and improved varieties of existing crops to remain profitable.

#### **What has been done**

The USU Integrated Pest Management program partnered with the Utah Climate Center to develop web-based tools to help farmers in Utah get timely access to site-specific crop management information. Named Utah TRAPs (Temperature Resource and Alerts for Pests), this collaboration produces real-time pest management information and weather conditions through a website, mobile app, and customizable alerts for over 70 locations in Utah and Idaho.

#### **Results**

These tools have helped a majority (93%) of the largest fruit growers in the state save thousands of dollars per acre in operating costs by optimizing pesticide applications, irrigation monitoring, and reduction in wind machine use for frost protection.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse

**Outcome #2**

**1. Outcome Measures**

Number of clientele who implement sustainable energy practices

Not Reporting on this Outcome Measure

**V(H). Planned Program (External Factors)**

**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

**Brief Explanation**

{No Data Entered}

**V(I). Planned Program (Evaluation Studies)**

**Evaluation Results**

The USU Integrated Pest Management program partnered with the Utah Climate Center to develop web-based tools to help farmers in Utah get timely access to site-specific crop management information. Named Utah TRAPs (Temperature Resource and Alerts for Pests), this collaboration produces real-time pest management information and weather conditions through a website, mobile app, and customizable alerts for over 70 locations in Utah and Idaho. These tools have helped a majority (93%) of the largest fruit growers in the state save thousands of dollars per acre in operating costs by optimizing pesticide applications, irrigation monitoring, and reduction in wind machine use for frost protection.

**Key Items of Evaluation**

**V(A). Planned Program (Summary)**

**Program # 4**

**1. Name of the Planned Program**

Childhood Obesity, Nutrition and Community

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
608	Community Resource Planning and Development	5%		11%	
702	Requirements and Function of Nutrients and Other Food Components	0%		35%	
703	Nutrition Education and Behavior	10%		10%	
724	Healthy Lifestyle	4%		3%	
801	Individual and Family Resource Management	16%		3%	
802	Human Development and Family Well-Being	8%		10%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	3%		17%	
806	Youth Development	54%		11%	
	<b>Total</b>	100%		100%	

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Year: 2016	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	56.0	0.0	6.2	0.0
<b>Actual Paid</b>	52.1	0.0	6.0	0.0
<b>Actual Volunteer</b>	0.0	0.0	0.0	0.0

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
996886	0	261582	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
996886	0	261582	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1229968	0

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

1. Conduct research with respect to human nutrition, family finances, bankruptcy, and community development.
2. Publish studies and make presentations related to individuals, family finances, and community well-being.
3. Conduct workshops and meetings, deliver activities, develop new curricula, write newsletters and news releases and post Internet fact sheets.
4. Provide training in a variety of mediums-face-to-face, satellite, group discussions, demonstrations, conferences and workshops, via DVDs, CDs, fact sheets, newsletters, and other media.
5. Include the following materials or media sources in training sessions: Take Charge of Your Money, Power Pay and Power Saves, Utah Saves Education and Outreach, Individual Development Account, First Time Homebuyer Assistance, Financial Education for Bankruptcy Filers (USU is certified by the Department of Justice to offer debtor education classes), Living Well on Less, Money Sense for Your Children, and Earned Income Credit assistance.
6. Utilize different teaching methods of The Utah Food Stamp Nutrition Education including individual, group classes, DVD video series, and an on-line course. FSNE Nutrition Education Assistants will provide other nutrition education opportunities to FSNE participants
7. Use the "Give Your Body the Best" curriculum developed in 2005 by USU to teach individuals or groups of low income persons regarding chronic diseases; on food allergies, intolerance, and poisoning; and lessons on getting to know foods and enjoy them.
8. Increase the capacity among other extension personnel to participate in or lead community self-assessments (SWOT analyses, asset mapping, search conferencing, surveys, etc.) that lay the groundwork for subsequent project activities.
9. Conduct research experiments and/or develop theories that can be used to explain (a) causes for public land conflicts and potential solutions, (b) solutions to the urban expansion into rural areas and open space, and (c) conditions for continued rural community economic viability.
10. Publish studies and make presentations related to these areas of concern.
11. Conduct workshops and meetings to educate local, state, and regional stakeholders concerning these issues.
12. Deliver educational and informational services through various media.
13. Develop educational resources related to rural economic viability for community leaders and other stakeholders
14. Provide for local training in principles developed that are related to this area of study.
15. Conduct design activities (for a park, a Main Street revitalization, etc.) that will typically yield a design of variable specificity (some might be conceptual drawings, others might be more extensive).
16. Provide consultations regarding land use planning policies and their implications on growth.

**2. Brief description of the target audience**

The target group is the general population of Utah (including youth), with a special emphasis on Native Americans, Latinos, African Americans, Asians/Pacific Islanders, and low income families with children at or below poverty levels, food stamp program eligible individuals, and individuals facing bankruptcy. A subgroup of the audience targets is pregnant teens and teen mothers.

Elected officials, appointed officials, general population (including youth), and at-large community opinion leaders and influential people are targeted for community development.

**3. How was eXtension used?**

Amanda Christensen serves as one of eight guiding committee members of the National Educational Technology Learning Network (EdTechLN) sponsored through eXtension. They provide examples of how to successfully integrate technology into our jobs as Extension professionals. They provide sharing and learning opportunities via twitter chats, blog posts, presentations at professional development conferences and curate the content found on our website: extedtechs.org.

Paul Hill is Community Strategy Leader for the Ed Tech Learning Network. He works to improve technology adoptions among Extension professionals via Twitter chats, blog posts, hands-on training opportunities, conference and workshop sessions, one-on-one peer coaching, and hosting webinars. This network attracts early adopters who will recruit new members to engage in this learning network to accelerate the discovery, sharing, evaluation, and utilization of technology tools by Extension professionals.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	132215	1119254	298791	2529388

**2. Number of Patent Applications Submitted (Standard Research Output)**

**Patent Applications Submitted**

Year: 2016  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2016	Extension	Research	Total
<b>Actual</b>	0	30	30

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- {No Data Entered}



**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of clientele who gain knowledge about nutrition education and behavior.
2	Number of clientele who implement practices of nutrition education and behavior.
3	Number of clientele who gain knowledge about individual and family resource management.
4	Number of clientele who implement individual and family resource management.

**Outcome #1**

**1. Outcome Measures**

Number of clientele who gain knowledge about nutrition education and behavior.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Knowledge Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	12440

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Utah residents experience poor health and nutrition, rising health care costs, increase in chronic disease, mental health incidents, and obesity rates, sedentary lifestyles, and additional unhealthy environmental factors.

**What has been done**

The Healthy Habits program enrolled community members to participate in three six-week challenges to assist them in acquiring healthy habits. Weekly health tips were emailed, three information classes were held, weekly tracking was reviewed, and pre and post health assessments were completed.

**Results**

Knowledge was gained about health and wellness topics, behavior was changed to reflect better daily habits, daily exercise and water intake increased, BMI decreased along with weight loss, perceived overall health improved, and better body strength and flexibility was developed.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
608	Community Resource Planning and Development
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior

724	Healthy Lifestyle
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

**Outcome #2**

**1. Outcome Measures**

Number of clientele who implement practices of nutrition education and behavior.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	3710

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Approximately 15 percent of Utah seniors face the threat of hunger and over 50,000 seniors reported that they are currently struggling with hunger. Seniors comprise approximately 10% of Salt Lake County's total population (110,000 seniors in Salt Lake County). Source 2010 US Census.

**What has been done**

Produce was donated from the USU Extension managed Meals Plus Harvest Garden, Wheeler Farm, Green Urban Lunchbox (local not-for-profit) and Bell Organic (local urban farm). The pop-up senior center farmers markets were a huge success with increasing numbers of seniors taking advantage of free produce with each passing week (average 39 seniors, range 18-100 seniors per event). The program serviced a total of 1,087 seniors in its pilot year.

**Results**

Ninety-seven percent of recipients reported the program had a positive impact on them, 96% said the produce helped them save money at the grocery store, 85% said their consumption of fruits and vegetable increased, and 95% reported the produce contributed to a healthier diet.

#### 4. Associated Knowledge Areas

<b>KA Code</b>	<b>Knowledge Area</b>
608	Community Resource Planning and Development
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
724	Healthy Lifestyle
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

#### Outcome #3

##### 1. Outcome Measures

Number of clientele who gain knowledge about individual and family resource management.

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

<b>Year</b>	<b>Actual</b>
2016	5158

##### 3c. Qualitative Outcome or Impact Statement

###### **Issue (Who cares and Why)**

In recent years, Utah has ranked among the highest in the number of bankruptcies and mortgage foreclosures. Due to high credit card debt, unemployment, larger homes and cars, and the desire to keep one parent at home with the children, families are experiencing much difficulty in making ends meet. Residents are in need of educational opportunities that focus on money saving tips and financial management topics.

###### **What has been done**

Utah Saves, the Individual Development Account Program, Smart Money Moves, and other finance programs were offered. Finance programming for the Latino Community was also be

offered using curriculum developed in Cache County. A series of three classes was taught four times during 2016 in Cache County in January, April, September, and November reaching a total of 125 participants. Completion of these workshops is the first step in participants being able to begin the qualification process for an Individual Development Matched-Savings Account. This will enable them to receive a 300% return on their savings for a home, business, or education.

**Results**

Thirty-one new IDA accounts, as of Dec. 1, in Cache County in 2016 where 20 successfully completed the savings program to receive \$4,500 in matched savings. Additionally 28 people who took the 2016 classes in Cache County became an IDA saver.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
608	Community Resource Planning and Development
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
724	Healthy Lifestyle
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

**Outcome #4**

**1. Outcome Measures**

Number of clientele who implement individual and family resource management.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	1190

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

The manufacturing sector plays a major role in Utah's economy. Small and medium sized manufacturers confront major problems in responding to increasing global competition. These problems encompass a broad range of issues, only some of which relate directly to technology. Inadequate resources, people, money, expertise, information, and insufficient time are reasons that many small industrial firms are not improving their manufacturing performance.

**What has been done**

Priorities for this program will come from a strategic focus on Utah's small manufacturers and on Utah's supply chain linkages. Priority to service delivery will be given to those objectives that best conform to the mission of the MEP, which is; "To raise the competitiveness, performance, and profitability of Utah's manufacturers".

**Results**

During 2016 (through 2 Quarters of NIST Surveys) in Utah 35 of 37 companies reported impacts including \$13,536,502 in increased sales and retained sales of \$50,455,002. Cost savings amounted to \$4,511,001. Total investment impact of MEP programming was \$44,012,312. There were 874 jobs created or retained through the efforts of MEP.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
608	Community Resource Planning and Development
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
724	Healthy Lifestyle
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

## **V(H). Planned Program (External Factors)**

### **External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

### **Brief Explanation**

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

The Healthy Habits program enrolled community members to participate in three six-week challenges to assist them in acquiring healthy habits. Weekly health tips were emailed, three information classes were held, weekly tracking was reviewed, and pre and post health assessments were completed. Knowledge was gained about health and wellness topics, behavior was changed to reflect better daily habits, daily exercise and water intake increased, BMI decreased along with weight loss, perceived overall health improved, and better body strength and flexibility was developed.

### **Key Items of Evaluation**

**V(A). Planned Program (Summary)**

**Program # 5**

**1. Name of the Planned Program**

Food Safety

Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
311	Animal Diseases	0%		14%	
501	New and Improved Food Processing Technologies	0%		29%	
502	New and Improved Food Products	0%		14%	
504	Home and Commercial Food Service	60%		0%	
701	Nutrient Composition of Food	0%		14%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	40%		29%	
<b>Total</b>		100%		100%	

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
<b>Plan</b>	2.0	0.0	2.6	0.0
<b>Actual Paid</b>	3.4	0.0	2.7	0.0
<b>Actual Volunteer</b>	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)



Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
65056	0	72448	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
65056	0	72448	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	334224	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

1. Conduct experiments and develop theories that can be used to develop a safer food supply from production, through processing, and to the final consumer.
2. Conduct experiments and develop theories that can be used to develop new food products or improve existing food products.
3. Publish studies and make presentations related to these two areas of concern.
4. Extend research to Utah residents, family consumer scientist agents, small and medium sized food processors, restaurant food safety managers to provide educational training and in-depth information on: safe food handling practices, safe food preservation and storage practices, certification to food safety managers, safe food handling practices for processors, and 4-H nutrition and health safety curricula and programs.

**2. Brief description of the target audience**

The target audience will include food processors, agricultural producers, general consumers (both within and without Utah), family consumer science agents, at risk groups and their families, and other scientists.

**3. How was eXtension used?**

eXtension was not used in this program

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	5357	111021	1707	35377

**2. Number of Patent Applications Submitted (Standard Research Output)**  
**Patent Applications Submitted**

Year: 2016  
Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

<b>2016</b>	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Actual</b>	0	20	20

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- {No Data Entered}

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Number of clientele who gain knowledge about home and commercial food service.
2	Number of clientele who implement home and commercial food service practices.

## **Outcome #1**

### **1. Outcome Measures**

Number of clientele who gain knowledge about home and commercial food service.

### **2. Associated Institution Types**

- 1862 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	5635

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

According to USDA food safety recommendations bacteria, yeasts and molds can grow in home-canned foods if not preserved properly. In addition, low-acid foods are at risk for clostridium botulinum which can grow into the food-borne illness botulism.

#### **What has been done**

Food preservation and food safety education is taught in order to prevent food-borne illness, to protect the time and money investment that families put into preserving food, and to help preserve food to eliminate food waste.

#### **Results**

Evaluations of the Master Food Preserver Series measure both knowledge gain and intent to change food safety behaviors. Knowledge gained included where to look for safe canning resources changed from 23% above average or excellent knowledge to 92%. The change in knowledge of necessity of adjusting processing times/pounds of pressure for altitude went from 15% above average and excellent to 92%; liquid poured into a jar of fruit should always be hot 15% to 92% above average and excellent; most vegetables need to be blanched prior to dehydrating 14% to 79% above average and excellent; vent pressure canner for 10 minutes prior to building pressure 15% to 92% above average and excellent; add acid to tomato products 17% to 100% above average and excellent; and the need to process all jam and jelly products went from 30% to 90% above average and excellent.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
311	Animal Diseases

- 501 New and Improved Food Processing Technologies
- 502 New and Improved Food Products
- 504 Home and Commercial Food Service
- 701 Nutrient Composition of Food
- 712 Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

**Outcome #2**

**1. Outcome Measures**

Number of clientele who implement home and commercial food service practices.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2016	3921

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

Bacteria and other air particles can grow on food if not preserved accurately. These particles can grow into food-borne illnesses that can spoil food, inflict illness in individuals who eat the food, or even cause death in severe cases.

**What has been done**

Canning and food storage classes attracted 1,836 participants last year. Over 659 pressure canning gauges were checked for safety and 63 volunteers were trained as Master Food Preservers.

**Results**

This service possibly prevented botulism for these consumers and their families.

**4. Associated Knowledge Areas**

**KA Code    Knowledge Area**

311	Animal Diseases
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
504	Home and Commercial Food Service
701	Nutrient Composition of Food
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

#### **V(H). Planned Program (External Factors)**

##### **External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

##### **Brief Explanation**

#### **V(I). Planned Program (Evaluation Studies)**

##### **Evaluation Results**

Food preservation and food safety education is taught in order to prevent food-borne illness, to protect the time and money investment that families put into preserving food, and to help preserve food to eliminate food waste. Evaluations of the Master Food Preserver Series measure both knowledge gain and intent to change food safety behaviors. Knowledge gained included where to look for safe canning resources changed from 23% above average or excellent knowledge to 92%.

The change in knowledge of necessity of adjusting processing times/pounds of pressure for altitude went from 15% above average and excellent to 92%; liquid poured into a jar of fruit should always be hot 15% to 92% above average and excellent; most vegetables need to be blanched prior to dehydrating 14% to 79% above average and excellent; vent pressure canner for 10 minutes prior to building pressure 15% to 92% above average and excellent; add acid to tomato products 17% to 100% above average and excellent; and the need to process all jam and jelly products went from 30% to 90% above average and excellent.

##### **Key Items of Evaluation**

## VI. National Outcomes and Indicators

### 1. NIFA Selected Outcomes and Indicators

<b>Childhood Obesity (Outcome 1, Indicator 1.c)</b>	
0	Number of children and youth who reported eating more of healthy foods.
<b>Climate Change (Outcome 1, Indicator 4)</b>	
0	Number of new crop varieties, animal breeds, and genotypes with climate adaptive traits.
<b>Global Food Security and Hunger (Outcome 1, Indicator 4.a)</b>	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
<b>Global Food Security and Hunger (Outcome 2, Indicator 1)</b>	
0	Number of new or improved innovations developed for food enterprises.
<b>Food Safety (Outcome 1, Indicator 1)</b>	
0	Number of viable technologies developed or modified for the detection and
<b>Sustainable Energy (Outcome 3, Indicator 2)</b>	
0	Number of farmers who adopted a dedicated bioenergy crop
<b>Sustainable Energy (Outcome 3, Indicator 4)</b>	
0	Tons of feedstocks delivered.