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	5%		10%	
204	Plant Product Quality and Utility (Preharvest)	10%		5%	
205	Plant Management Systems	10%		10%	
206	Basic Plant Biology	5%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	5%		5%	
212	Diseases and Nematodes Affecting Plants	5%		10%	
213	Weeds Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	5%		5%	
301	Reproductive Performance of Animals	5%		5%	
302	Nutrient Utilization in Animals	8%		3%	
304	Animal Genome	2%		2%	
305	Animal Physiological Processes	5%		2%	
306	Environmental Stress in Animals	2%		2%	
307	Animal Management Systems	15%		11%	
311	Animal Diseases	10%		8%	
315	Animal Welfare/Well-Being and Protection	3%		8%	
604	Marketing and Distribution Practices	0%		2%	
609	Economic Theory and Methods	0%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890

Plan	37.0	0.0	128.2	0.0
Actual Paid	27.8	0.0	160.8	0.0
Actual Volunteer	0.6	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**
878939	0	2310294	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2346655	0	12421590	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1122998	0	16699207	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MAES supported research in 2014 provided new information and strategies to improve major crop and animal production systems in Minnesota, along with supporting niche agriculture issues like organic dairy. Diseases threatening our crops and animals remain a primary concern for researchers. New opportunities to use breakthrough technologies in agriculture continue to be explored including remote sensing, robotics, and precision agriculture.

A key consideration for livestock researchers at the U is animal welfare in animal production systems. Researchers are discovering how to increase profitability while providing producers with information needed to provide a better environment for the animals.

A key area of research for crop improvement is on uncovering the genotypic and phenotypic diversity within crop types. Modern breeding practices have led to many high yield crops becoming too genetically similar which raises concern for pest management and the effects of climate change. Researchers are responding by searching historical plant databases for key genes to reintroduce and using genomic selection to speed up the breeding process while maintaining genetic diversity.

Research highlights for 2014 include:

- Experiments were conducted to determine yield and quality of commercial field beans and soybeans. Twelve new varieties were tested along with nine top performers from 2012-2013 at five locations. Results will be used to identify varieties adapted to upper Midwest organic systems.
- A research project on Pythium has revealed 31 different species in soybean fields in Minnesota. This number is far larger than has been previously known and reveals, in part, why this pathogen has been so difficult to manage.
- Genetic mapping tools have been successfully utilized to isolate the soybean genes responsible for photosynthesis and trichome development.
- Two new QTLs in soybean PI 567516C were found to be resistant to SCN. Marker-assisted selection will allow these new genes to be used in future breeding.
- A study on seed treatments for wheat found that only one out of eight environments treated resulted in

better initial stand compared to untreated controls. Furthermore, preliminary data for fungal isolations shows that while the seed and initial stand may be protected by treatment, mature plants are still susceptible to late-season infections.

• Genomic selection as a means of speeding up development of new wheat cultivars with desirable traits continues to move forward. Phenotype data was collected on lines in training and validation populations, and 90K SNP (single nucleotide polymorphism) genotyping was done.

• A field study was conducted to examine the distribution of soil borne diseases in commercial wheat fields in Minnesota. Fusarium Crown Rot was identified as the most prevalent root disease of wheat in the state.

• Researchers studying genetic markers for crop improvement found that every inbred line of barley crop surveyed contains deleterious mutations, on the order of 2,000 per inbred line.

• A study found that cultivated barley appears to have mosaic ancestry with genetic contributions evident from, and consistent with, adaptive contributions from wild populations.

• Researchers discovered the environmental association approaches being applied by evolutionary biologists are useful for identifying variants associated with precipitation and temperature variables in crop relatives. However, it remains that the most significant variants associated with climate adaptation are associated with chromosomal structural variation.

• A two-year study on fly management on organic dairy farms explored two alternative bedding forms - straw and sawdust compost. Results from sticky traps indicated that the number of adult stable flies in the area were statistically the same in both bedding situations. But the average straw bedding pile yielded 30,000 stable flies during the summer months compared to only 670 yielded from the average sawdust pile. Additional research on development time and survival rate is planned for 2015.

• Researchers investigating the presence of rotavirus H (RVH) in US pigs, identified RVH in 15% of fecal samples from 10 US states, suggesting that RVH has circulated in the United States since 2002, but probably longer.

• A test to develop foaming manure in the lab utilized long-chain fatty acids (LCFA) as surfactants to cause foaming. A high level of LCFA were found in the foam layer in foaming manure pits and tests showed adding and removing them in the lab change the ability for the manure to foam. More research is needed to determine where the higher levels of LCFAs are coming from.

• Research on levels of DDGS in feedstock has found that DDGS has minimal negative effects on pig health and does not cause Mulberry Heart Disease in young pigs.

• Continued research on sow welfare in group-housing systems revealed that producers may benefit from separating sows by age and weight as well as housing low ranking sows in smaller pens away from high ranking sows.

• Research continued on the development of a vaccine for Johne's disease. Researchers were able to isolate, expand, and sort dendritic cells from two cows.

• Efforts to enhance the reproductively efficiency of turkey found evidence that: (1) the premammillary nucleus (PMM) is a site for photoperiodic time measurement that controls the initiation and termination of avian reproductive seasonality, and (2) the GABAergic system has a prominent role in the regulation of light neurotransmission in the PMM. These findings can be used to find methods to increase reproductive efficiency by eliminating photorefractoriness in turkeys.

• In 2013, we mentioned a new partnership with APHIS to collect samples from double-crested cormorants during the 2013 breeding system. This year we can announce that preliminary analysis of the data has allowed the production of an 'atlas' of the cormorant's hypothalamus, and verification of the localization of primary structures, including the PMM, that is specific to the species.

• Researchers studying Newcastle disease collected and tested 359 cormorant eggs of which 304 (85 percent) tested positive. No outbreak of Newcastle disease took place in 2014 (despite historical patterns implying it would). Researchers hypothesize the high level of seropositivity in the eggs in 2013 and 2014 indicate that females were largely antibody positive both years which may have been indicators that no outbreak would occur.

Extension:
Minnesota crop and livestock producers faced challenging conditions in 2014 that Extension programs helped address. The difficult winter of 2013-2014 and a late, wet spring created planting problems. There was significant alfalfa acreage loss across the five state region and Canada, so Extension responded with education on forage production and use. Minnesota farmers also saw increasing problems with herbicide resistant weeds in their corn and soybean fields. Corn rootworm caused more damage and the soybean cyst nematode spread further and infected more fields. Extension focused on finding and demonstrating new strategies for weed management, and Extension educators and specialists educated about the use of cover crops to improve soil and manage pests.
Climate change caused heavy weather events and some Minnesota fields flooded while others experienced drought. These challenges, along with smaller profit margins, increased farmers' interest in going back to the basics and paying close attention to management practices. Extension education offered farmers practical support to sustain their operations in changing times. Extension programs also explored new opportunities for using remote sensing and mining big data technology to give farmers more management options. This included, for example, the potential of using climate data for custom weather forecasts to predict the amount of precipitation by field and to establish estimates for weed emergence dates.
Some highlights of activities and outcomes from 2014 Extension programming:

- Severe summer weather caused hail damage to parts of southwestern Minnesota corn and soybean fields and Extension responded with an emergency Hail Clinic held at a farmer that had been hard hit. More than 160 local farmers, agricultural professionals and agency personnel attended. Extension crops educators and specialists were able to help advise growers on what fields could recover, what fields were a loss, and options for cover crops or replanting.
- Eighty-nine percent of attendees of Private Pesticide Applicator Recertification workshops reported that, as a result of the workshop, they were more likely to continue or increase the use of crop rotation for corn rootworm management. Ninety-seven percent reported that they were more likely to monitor pests and base their pesticide treatment on threshold levels.
- The Minnesota Hay Bank was formed in 2012 in response to increasing equine-related humane cases and historically high hay prices. By the end of 2014, it had distributed more than 222 tons of hay providing emergency feed assistance to improve horse welfare.
- The research and extension work done on compost barns in Minnesota has received international recognition. The Extension specialist in cow comfort was invited to speak on the program in Denmark and Brazil. As a result, Brazil now has more than 95 farms using a system based on U of Minnesota Extension recommendations, with adaptations for their environment.
- Extension educators and specialists explain the Minnesota agricultural industry to non-agricultural audiences who need to understand farm practices better for their own work. In 2014, the Extension beef team changed a producer-focused educational program into a food service industry program, renaming the program BeefU. This exposed food service professionals to production chain reality -- from the families that raise beef to the corporations that process it and sell it in retail outlets.
- An emergency forage research program was established at sites in southeastern, central and west central Minnesota. Producers were made aware of warm season grass options that have the ability to provide forage within as little as 35 days after planning.

2. Brief description of the target audience

The primary audiences are producers of livestock, commodity crops, and small farms. Additional audiences are industry representatives who can assist in dissemination of valuable information. Collaborative relationships with state departments, local government jurisdictions, and regulating agencies

support and inform those who influence crop and livestock producers.

3. How was eXtension used?

Extension specialists offered a webinar through eOrganic, an eXtension community of practice. More than 50 people attended from the U.S. and also some international viewers. The webinar recording is on eOrganic's YouTube page.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	52670	3780760	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 1

Patents listed

201400242 3/19/2014 Linkert Wheat Variety

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	75	133	208

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Extension publications and presentations.
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of Extension learning opportunities.

Year	Actual
2014	3175

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Participants of Extension livestock and crop program workshops/classes and conferences will achieve significant learning gains regarding research-based knowledge and skills. (Target expressed as the percentage of participants who achieved significant learning gains as a result of attending Extension program workshops/classes and conferences.)
2	Participants of workshops/classes and conference sessions related to livestock and crop production will significantly improve their production practices as a result of attending the program. (Target expressed as a percentage of participants that significantly changed one or more of their practices as a result of attending workshops/classes and conference sessions intended to improve participant practices.)
3	Interventions will result in changes in conditions related to profitability, crop and livestock health or environmental conditions. (Target expressed as number of changes in condition reported each year.)
4	Research will support a more sustainable, diverse and resilient food system (Measure: number of new or improved innovations developed for food enterprises. Measure: number of new diagnostic systems analyzing plant and animal pests and diseases)
5	Development of new crop varieties will help Minnesota growers improve profitability
6	Research will provide information to support strategies to control animal diseases.
7	Extension will provide support in education and consultation to support dairy producers move to organic dairying. (Outcome is expressed as the amount of additional revenue generated by Minnesota dairy producers as a result of the organic market.)
8	Research will help booster the Minnesota barley industry by introducing new varieties and developing new industry opportunities for growers.
9	Research will provide information to help policymakers assess the feasibility of feeding the world's growing population in the coming decades.

Outcome #1

1. Outcome Measures

Participants of Extension livestock and crop program workshops/classes and conferences will achieve significant learning gains regarding research-based knowledge and skills. (Target expressed as the percentage of participants who achieved significant learning gains as a result of attending Extension program workshops/classes and conferences.)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	40

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Corn and soybeans are the most economically important crops in Minnesota, planted on more than 15 million acres. Glyphosate is the most widely-used herbicide, due primarily to the development of glyphosate-resistant corn and soybean. Repeated use exposes weeds to selection pressure, which leads to resistant weeds. Many weeds resistant to glyphosate are also resistant to other herbicides. Farmers need new and integrated weed management strategies to cope with the problem.

What has been done
An Extension survey found 80 to 100 percent of growers have found that glyphosate has not been performing as well as when they first used it. Asked how long they had been applying it, 63 percent said 20+ years. Extension programming educated growers about other options including rotation, hand pulling, mechanical weed control and manipulating planting dates. These management-intensive strategies require understanding of weed biology. Educators established local field plots and did cultural studies with six different crop rotations.

Results
In evaluations after training sessions, 40 percent of farmers said they are convinced they need to make changes in their cropping systems to manage weeds. These include better targeting of weeds, cultivation, and rotation with crops such as alfalfa or winter wheat that could disrupt weed resistance. Some of the traditional practices were shown to be less expensive and time-consuming than farmers think, especially when precision agriculture tools are added to the mix.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants

Outcome #2

1. Outcome Measures

Participants of workshops/classes and conference sessions related to livestock and crop production will significantly improve their production practices as a result of attending the program. (Target expressed as a percentage of participants that significantly changed one or more of their practices as a result of attending workshops/classes and conference sessions intended to improve participant practices.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	98

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Minnesota has 26 million acres of farmland, but only 480,000 acres, or 1.5 percent, are cover crops. Cover crops aid in suppressing herbicide resistant weeds, help farmers manage fields experiencing heavy weather events and improve soil health. But Minnesota corn and soybean growers are unfamiliar with the possibilities as well as the technology for planting cover crops into standing corn.

What has been done
Extension crop specialists and educators developed a research and demonstration project that furthers knowledge about cover crop options and results. There is a wide range of cover crops available, but in some areas a farmer may have limited options. Specialists and educators put together a team including farmers and a local watershed district to plan a field day to share results from the project. About 185 farmers attended the field day, far exceeding original expectations.

Results
One hundred percent of evaluation respondents indicated they had a deeper understanding of the subject matter and 98 percent said they had situations in which they could use what they learned to change at least one of their practices. One farmer who decided to take Extension advice and use cover crops for the first time planted a new variety of oilseed radish. He left it through the winter with no tillage, and his summer soybean crop thrived. Extension's cover crop demonstration plots and education offer farmers options to maintain profitability, control weeds and nourish the soil. As a result of increasing interest in cover crops and the benefits demonstrated by Extension, an Extension crops educator was invited to Washington to testify at a soil health hearing of the House Agriculture Committee in September 2014.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
212	Diseases and Nematodes Affecting Plants
213	Weeds Affecting Plants

Outcome #3

1. Outcome Measures

Interventions will result in changes in conditions related to profitability, crop and livestock health or environmental conditions. (Target expressed as number of changes in condition reported each year.)

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Porcine epidemic diarrhea virus (PEDV) is a severe threat to the United States swine industry. The U.S. was considered free of PEDV until April 29, 2013, when U.S. PEDV cases were first

detected in west central and eastern Iowa. Within weeks, PEDV was identified in central Illinois, Minnesota, and Colorado. The disease effects can be devastating because pigs have no immunity. Mortality rates of 100 percent have been reported in young pigs.

What has been done
Extension's success with controlling new diseases has always depended on sharing timely recommendations and information. With Extension involvement and cooperation, a voluntary group of Minnesota pork producers have met quarterly to encourage open dialogue about the health status of pig herds. This shared information can help contain a disease to single farm because of increased communication with veterinarians, feed delivery, manure haulers and any other industry that does business at pig farms.

Significantly, researchers confirmed that there is no relation between PCV2 levels and PEDV disease status. Thus PCV2 strategies do not have to be adjusted in the event of PEDV outbreaks.

Results
The quantitative outcome refers to all evaluated programs. The pig farms were able to redirect feed delivery, manure hauling, and pig-flow, which minimized exposure and transfer of the virus to other pig sites. Without this effort, many more positive cases of PEDV could have occurred. Locally, reducing the impact of PEDV disease will directly benefit the Minnesota pork industry, which is ranked second in production in the United States, and valued in excess of 6.9 billion dollars in gross income annually to the state of Minnesota.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

Outcome #4

1. Outcome Measures

Research will support a more sustainable, diverse and resilient food system (Measure: number of new or improved innovations developed for food enterprises. Measure: number of new diagnostic systems analyzing plant and animal pests and diseases)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Obesity during gestation increases the risk for maternal and offspring health disorders in dairy cows. Obesity also increases the risk of cows experience gestational weight loss (GWL) which affects approximately 35 percent of dairy cows in the U.S.

What has been done
Researchers completed a multi-year study that included data from over 1000 cows and nearly 500 heifers. They compared GWL incidence among obese and normal weight cows as well as the effects of GWL on both dam and offspring before addressing the causes of GWL and potential solutions. They found a reduced concentration of IGF-1 (insulin like growth factor 1) is a key aspect of GWL and it has a damaging effect on to the immune system and health of the dam and by extension the health and development of the offspring. From this they developed a strategy to produce an elevated IGF-1 concentration during the prepartum period to correct the low concentrations observed in cows experiencing GWL.

Results
To date this new therapeutic strategy has proved to resolve the immunosuppression of the dam and has resulted in reduced incidence of infectious disease (metritis) and increased body weight and survivability of the offspring at birth. This strategy and the results were presented at the American Dairy Science Association meeting in July 2014 and have been shared with regional dairy producers and veterinarians.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems
311	Animal Diseases
315	Animal Welfare/Well-Being and Protection

Outcome #5

1. Outcome Measures

Development of new crop varieties will help Minnesota growers improve profitability

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Minnesota being on the northern edge of where soybeans are produced means new breakthrough soybean traits and varieties developed by the private sector are not adapted to our growing conditions. Despite this, soybeans are now the second most valuable crop grown in Minnesota (after corn) with a production value of over $3 billion in 2014.

What has been done
U of M soybean breeders have concentrated on developing high yield soybean varieties with healthier profiles and desirable traits that are uniquely adapted to growing conditions in Minnesota. Hundreds of soybean varieties have been developed and released since the breeding program began in 1946, including six new varieties in 2014. Released varieties include both specialty use and general use soybeans and since the 1980s have incorporated key traits and disease resistance such as SCN (soybean cyst nematode).

Results
Since 1946, the number of acres of soybeans planted in MN has grown from tens of thousands to over 7 million acres. Soybeans are now the #1 agricultural export for the state and are used for a variety of purposes including food, animal feed, biodiesel, and other soy-based products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants

Outcome #6

1. Outcome Measures

Research will provide information to support strategies to control animal diseases.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Extension will provide support in education and consultation to support dairy producers move to organic dairying. (Outcome is expressed as the amount of additional revenue generated by Minnesota dairy producers as a result of the organic market.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1600000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The number of organic dairy producers in Minnesota continues to grow, and the state now ranks ninth in the country, with more than 200 organic dairy farms. This success story is due to Extension's efforts to change conventional dairy operations to organic.

What has been done
Seeing the potential for organic dairy markets, Extension began working with dairy producers seven years ago to convert dairy production to organic. Extension began working with five dairy farms to convert operations in 2007. The number of farms considering the option has grown steadily, and with Extension effort in 2014, four additional farms are posed to switch.

Results
Dairy farmers have said, "I wouldn't be farming if it wasn't for the change we made. The proof is in the profits. As a result of 600 dairy cows converted from conventional to organic, with the differential price between organic and conventional milk at about 17 cents per pound, $1.6 million of additional new revenue now comes to Minnesota's dairy producers every year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #8

1. Outcome Measures

Research will help booster the Minnesota barley industry by introducing new varieties and developing new industry opportunities for growers.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Profitable barley production in the Midwest is dependent on growing barley varieties that are approved by the malting and brewing industries and meet their grain specifications. Barley production is at an all-time low due to the increased profitability of other crops that can now be grown in the upper Midwest. Additionally, the reemergence of barley diseases has led to a dramatic decline in barley production over the last 10 years.

What has been done
The University's spring barley breeding program focuses on varieties suited to the malting and brewing industries that are willing to pay a premium to farmers that grow a high quality crop. As such, the primary traits of interest are yield, malting quality traits, and disease resistance, in particular Fusarium head blight which renders barley unusable for malting and brewing.

In addition, a new breeding effort began in 2013 to develop two-row varieties which are desirable for microbreweries in Minnesota (as opposed to the six-row varieties that large national brewers prefer).

Results
Developing new and improved malting barley varieties for the Midwest directly impacts farmers by improving their profitability and helping to create a reliable grain supply for the malting and

brewing industries. Recent barley introductions from the University have been popular with 'Robust,' 'Lacey,' and 'Quest' being grown on just under 81,225 acres in MN and ND in 2014 (representing 12 percent of the acreage planted). Additionally, an on campus tour with craft and microbrewers was conducted to show them the two-row breeding program and solicit feedback. Nationwide, craft brewing is a $10 billion industry, growing at a rate of more than ten percent per year. The number of craft breweries in the state has Minnesota ranked #20 nationwide. Craft brewers and two-row barley represent an excellent opportunity to revive Minnesota's barley industry in the coming years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
204	Plant Product Quality and Utility (Preharvest)
206	Basic Plant Biology

Outcome #9

1. Outcome Measures

Research will provide information to help policymakers assess the feasibility of feeding the world's growing population in the coming decades.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Concerns over the long-run future of global food and agriculture have resurfaced in recent years. Spurred by population, income and biofuels growth, many expect agricultural demands to double by the middle of the century. Others foresee looming land shortages with needs of biofuel taking land needed to supply the food to the word's population.

What has been done
Economists at International Science and Technology Practice and Policy (InSTePP) addressed

these competing concerns on the future of agriculture in a new study using the International Agricultural Prospects (iAP) model.

Using this model researchers see a future where agricultural consumption increases more modestly than many predict--by around 69 percent (1.3 per cent per year) from 2010 to 2050 using midline population growth projections. Key considerations that led to this conclusion are:
(1) According to the UN we have hit a turning point in population growth with (midline) 2010 to 2050 growth rates projected to be about half the rate of the previous half century.
(2) The world's population is aging. iAP indicates that countries with younger (under 20 years old) or older (over 60 years) populations tend to consume fewer calories on average.
(3) In 2010, the world consumed 7,145 trillion kilocalories of agricultural output as food. The model projects growth to 10,908 trillion kilocalories by 2050 with an additional 7 percent of calories coming from livestock sources.
(4) Biofuels production is projected to grow, totaling 303 billion liters in 2050 (versus 113 billion in 2011) but some of this land diversion will be limited by technological advances in the conversion of agricultural feedstocks to biofuel.
(5) In 2011, 62.4 percent of biofuel feedstock was sugarcane, which the model projects to grow to 73.3 percent by 2050 limiting the effect of increased biofuel requirements on corn, soybean and canola.
(6) The model projects crop yields to continue to grow but at a slower rate averaging an increase of 1.3 percent per year from 2010-2050.
(7) Forty-three percent of the world's suitable cropland was harvested in 2010. iAP projects between 41 and 56 percent of suitable cropland will be required to meet 2050 agricultural consumption.

Results
This new model shows how sustainably feeding the world's growing, more urbanized, and aging population may be accomplished over the next thirty-five years without disrupting the land currently used for forestland and meeting all increasing requirements for biofuel.

The model showcases how the task is doable but will require cooperation from U.S. and international policy makers, agricultural and environmental researchers, and even agricultural producers to be affective.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
604	Marketing and Distribution Practices
609	Economic Theory and Methods

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Natural Disasters (drought, weather extremes, etc.)

Brief Explanation

Goals were achieved, but programs changed dramatically to address extreme weather conditions.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Extension's Institute for Agricultural Professionals has a long history and has three large educational events at its core that are repeated across the state, providing agricultural professionals more than 50 percent of their continuing education credits. A 2014 evaluation looked at whether the program was reaching new and intended audiences and meeting the needs of participants. It showed the Field School for Agricultural Professionals has the highest attendance for first time participants, thus meeting the goal of the program to reach new industry staff. The 2014 Research Update for Agricultural Professionals was held at six locations across Minnesota, and results of the evaluations revealed that attendance was the fourth highest since 2005, with 410 participants. When agricultural professionals were asked about the number of clients and acres they had contact with, they indicated they had on average 46 clients with an average of more than 46,000 acres. Thus, the program had a potential impact on 4 million acres across the state and surrounding regions. Seventy-five of respondents planned to use the session information to make recommendations to others, and 54 percent planned to share knowledge with growers and the public.

Key Items of Evaluation

Extension evaluated a major group of events for agricultural professionals held at six locations across Minnesota. The post-event evaluation indicates that agricultural professionals were each bringing information from the event to an average of 46 clients managing an average of more than 46,000 acres. Thus, the program had a potential impact on 4 million acres across the state and surrounding regions. Of the respondents, 75 percent planned to use the session information to make recommendations to others, and 54 percent planned to share knowledge with growers and the general public.