V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Agricultural, Natural Resource, and Biological Engineering

☑ 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
401	Structures, Facilities, and General Purpose Farm Supplies	0%		10%	
402	Engineering Systems and Equipment	0%		10%	
403	Waste Disposal, Recycling, and Reuse	0%		63%	
404	Instrumentation and Control Systems	0%		13%	
405	Drainage and Irrigation Systems and Facilities	100%		4%	
	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	3.6	0.0	2.5	0.0
Actual Paid	4.4	0.0	2.4	0.0
Actual Volunteer	0.1	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**
170827	0	25190	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
170827	0	27175	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct Research to Produce Graphene from Biochar
- Investigate the Impact of Manure Management Practices
- Conduct Research to Create New Sources of Biomass
- Conduct Drainage and Water Management Design Workshops

2. Brief description of the target audience

- Supercapacitor and Energy Industries
- Livestock Facilities
- Biofuel Industry
- Scientists
- Farmers
- Landowners
- Drainage Contractors

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2849	116796	856	4573

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

Patent Applications Submitted

Year:	2014
Actual:	2

Patents listed

1. Exhaust System/Air Filtration Method
2. Rotating Fluidized Bed for Catalytic Pyrolysis

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	22	22

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Percentage of all Hatch Research Projects in Agricultural, Natural Resource, and Biological Engineering

Year	Actual
2014	2

Output #2

Output Measure

- Number of Drainage and Water Management Design Workshops

Year	Actual
2014	4

Output #3

Output Measure

- Conduct Research on Carbon Materials and Biofuel Technologies

Year	Actual
2014	0

Output #4

Output Measure

- Number of Publications Posted on iGrow Website

Year	Actual
2014	36

Output #5

Output Measure

- Number of Articles Posted on iGrow Website

Year	Actual
2014	91

Output #6

Output Measure

- Number of Podcasts Posted on iGrow Website

Year	Actual
2014	5

Output #7

Output Measure

- Number of Radio Programs Posted on iGrow Website

Year	Actual
2014	34

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of Agricultural, Natural Resource, and Biological Engineering Hatch Research Projects
2	Number of Drainage and Water Management Design Participants
3	Enhance Understanding of Bio-renewable Graphene Production

Outcome #1

1. Outcome Measures

Number of Agricultural, Natural Resource, and Biological Engineering Hatch Research Projects

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Livestock facilities are growing in size and are increasingly coming under air and water quality regulations. Data is needed for improved site-specific estimates of emissions and manure nutrient values. Research is also needed in biomass technology to enhance the energy security of the United States.

What has been done
Within the College of Agricultural and Biological Sciences, there are three Hatch projects that are categorized in the Planned Program of Agricultural, Natural Resource, and Biological Engineering. Projects include manure odor reduction, lignocellulosic based bio fuel, and the development of microorganisms to facilitate composting of plant materials.

Results
Through research, our Department of Agricultural and Biosystems Engineering has continued to build its knowledge base that impacts new innovations and design systems in agriculture. Examples include:
The impact of manure management practices on air quality and nutrient value from mono-sloped beef cattle facilities, development of biochemical or thermochemical pretreatment technologies that lead to the economical production of lignocellulosic based bio fuel, and to further characterize microbial samples that might have ability to both fix dinitrogen gas and break down some components of lignocellulose. In addition, graduate students gain valuable knowledge and skills while collaborating on research projects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #2

1. Outcome Measures

Number of Drainage and Water Management Design Participants

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	205

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increases in precipitation and land and commodity prices along with new technologies have led to increased interest in subsurface (tile) drainage to address excess moisture concerns. Good drainage design requires an understanding of soils, topography, drainage system, legal, and environmental factors. Improper drainage design results in systems that provide less than desired benefits or greater than desired environmental impacts.

What has been done
A multistate effort among SDSU Extension and North Dakota State University and the University of Minnesota Extension services, along with industry partners, conducted workshops that included topics on drainage design fundamentals, managed drainage design, soil principles, lift stations, design tools, agronomic considerations, and legal and wetlands issues. The workshops concluded with participants working in small groups to design a drainage system for one of their own fields or an example field.

Results

Of the evaluation respondents from the South Dakota workshop, 100% rated the overall program as useful or very useful. Six of the 12 workshop sessions were directly related to drainage design and generally rated highest for usefulness for knowledge gained from the workshop. Many participants indicated that the information they learned from the workshop would help them better design their own tiling projects, evaluate contractor designs, or advise clients on drainage design. Several participants also indicated that they would now consider drainage water management as a best management practice.

4. Associated Knowledge Areas

KA Code	Knowledge Area
405	Drainage and Irrigation Systems and Facilities

Outcome #3

1. Outcome Measures

Enhance Understanding of Bio-renewable Graphene Production

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)
Before supercapacitors can begin replacing batteries in tractors and powering electric cars, scientists must generate materials to fabricate electrodes for bigger supercapacitors. To manufacture these storage devices, the United States now imports most of its activated carbon from Asia.

What has been done
Through a process developed for a project aimed at producing activated carbon for water purification, biochar was successfully converted into graphene. Biochar is a charcoal like material obtained from pyrolysis of dried distillers grain solids (DDGS) and other plant materials that are abundant in South Dakota. Graphene can be used in place of expensive, activated carbon to coat the electrodes of energy storage devices - supercapacitors.

Results
When biochar of DDGS is transformed into graphene, the yield is from 70 to 90% (based on biochar, e.g. 20%-36% based on DDGS). Therefore, a pound of DDGS costs 7.5 to 9 cents and converts to approximately 3-5.7 ounces of graphene, which currently worth at least $75 ($400/lb according to the lowest price of current industrial manufactured graphene) with processing cost (cost of catalysts, labor, capital, transportation and management) less than $10. In summary, the bio-renewable graphene preparation technique will not only benefit farmers and biofuel producers with additional income, but will also benefit our country's advanced carbon materials and advanced energy storage device industries.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Western South Dakota experienced one its worst blizzards on record, killing an estimated 50,000 or more livestock. Valuable man-hours and resources had to be redirected for both livestock and non-livestock issues.

Salary and benefit increases have eroded the impact of federal funds, deferring vacancy fills in both SDSU Research and SDSU Extension.

Many of the research facilities at SDSU have exceeded their useful life and no longer accommodate the needs of the scientists in the Agricultural Experiment Station. Deferred maintenance and repair of facilities remain a serious limit to research, faculty recruiting and retention.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Subsurface Drainage Design and Water Management
Post workshop surveys with 16 respondents
Respondents reporting that workshops were useful or very useful:

100% - Design 1: Soil & Drainage Principles
88% - Legal Considerations of Drainage
100% - Design Session 2: Introduction to Design
63% - LiDAR Data

100% - Design Session 3: Comprehensive Design
94% - Design 4: Lift Station Design
69% - Software and sub-irrigation
81% - Safety
88% - Conservation Drainage Practices
100% - Design Session 5: Managed Drainage Design
88% - Wetland Delineations
87% - Design Session 6: Small Group Design Project

Key Items of Evaluation

Bio-Renewable Graphene Production
$400 - Cost of one pound of graphene at the lowest price of current industrial manufactured graphene
$53.28 - Cost of one pound of graphene when transformed from DDGS biochar plus all processing costs
Potential Return on Investment 651%

Subsurface Drainage Design and Water Management
Post workshop surveys with 16 respondents
Respondents reporting that workshops were useful or very useful:
88% - Average for all Workshops
99% - Average for Drainage Design (6 of 12 Workshops)
100% - Overall Entire Program