V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Sustainable Energy

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
204	Plant Product Quality and Utility (Preharvest)			23%	
206	Basic Plant Biology			44%	
511	New and Improved Non-Food Products and Processes			33%	
	Total			100%	

V(C). Planned Program (Inputs)

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

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Actual	0.0	0.0	2.4	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
0	0	213278	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	209302	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

Research efforts relating to sustainable energy revolved around native species found in the Great Basin that would serve as biomaterials and biofuels. Specifically, rabbit brush is being used for it latex production as well as its cellulosic-based feedstock to produce biodiesel; gum weed and gopher weed are being examined for their use in creating hydrocarbon compounds that are highly suited for the production of liquid biofuels; horticultural experiment are underway to determine if camelina (a new biofuel feed crop) is suitable for northern Nevada; and further investigations are now underway to determine oil production potential of 20 varieties of salt-loving algae.

2. Brief description of the target audience

Renewable energy industry, scientific community, NGOs, and the general public

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	{NO DATA	{NO DATA	{NO DATA	{NO DATA
Actual	232	50	70	75

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

Patent Applications Submitted

Year: 2010
Plan:
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	6	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed scientific publications, presentations at scientific meetings, presentations to stakeholder, workshops.

Year	Target	Actual
2010	{No Data Entered}	6

Output #2

Output Measure

- Demonstrations and Workshops Conducted

Year	Target	Actual
2010	{No Data Entered}	8

Output #3

Output Measure

- Leveraged Research Projects

Year	Target	Actual
2010	{No Data Entered}	11

Output #4

Output Measure

- Web Sites Created or Updated

Year	Target	Actual
2010	{No Data Entered}	3

Output #5

Output Measure

- Number of Graduate Students or Post-Doctorates Trained

Year	Target	Actual
2010	{No Data Entered}	15

Output #6

Output Measure

- Number of Undergraduate Students Involved in Research

Year	Target	Actual
2010	{No Data Entered}	10

Output #7

Output Measure

- Manuals and Other Printed Instructional Materials Produced

Year	Target	Actual
2010	{No Data Entered}	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Biofuels from Salt Basin Algae: An Energy Crop for Nevada
2	Rabbit Brush As A Multi-Use Industrial Crop For Biomaterial And Bioenergy Applications

Outcome #1

1. Outcome Measures

Biofuels from Salt Basin Algae: An Energy Crop for Nevada

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To fulfill the growing energy needs of Nevada, it is becoming increasingly clear that the state and country must invest in the development of alternative energy resources, such as biofuels, wind, solar and geothermal. The purpose of this study is to explore whether a salt-loving, pink algae, Dunaliella salina, can serve as a biofuels feedstock. Because this organism grows optimally in high saline environments, and is naturally occurring in various regions of the Great Basin, it appears to be well suited as a new alternative biofuels crop for Nevada.

What has been done
Analysis of growth rates, triacylglycerol, free fatty acid content, and insoluble starch content for nineteen strains of halophytic microalgae (D. salina) has been completed and analysis of results is being finalized for publication.

In addition, University of Nevada, Reno researchers have explored the use of centrate, the liquid fraction created when anaerobically digested wastewater sludge is dewatered for disposal purposes, as a low cost, nutrient source for growing algae.

The research team has also begun the sequencing of approximately 30 different freshwater green algae strains including Chlorella, Neochloris, and Nannochloropsis species.

The team is now in the process of selective breed D. salina through multiple generations looking for changes in lipid content. One discovery new to this field of science is that both buoyant density gradient centrifugation and flow cytometry followed by fluorescence activated cell sorting can be effectively used to select for significant increases in lipid and/or starch content algal cell populations without resorting to genetic engineering.

Other scientific advancements include the complete mitochondrial and plastid genome sequences

have now been published. Short sub-sequence of a transcribed DNA libraries derived from various environmental stress conditions by Sanger and Roche 454 sequencing produced over 1.5 M cleansed reads and about 21,000 unigenes. Analysis of a small collection of expressed sequence tags from salt-shocked D. salina cells was also completed.

In order to identify genes that control oil production, an experiment using a custom microarray has been completed with the largest change in gene expression patterns occurring after three days of nutrient deprivation.

Results
Despite the potential global economic importance of the pink algae Dunaliella salina, relatively little research has been done to understand its unique physiology and exploit it tremendous potential. While the federal government is increasing their investment into biofuel research, most of the attention is being giving to fresh water dependent crops that will need to be grown using existing agricultural land and water resources.

However, for Nevada, this is not a viable long-term strategy, as it will be politically and pragmatically un-reasonable to re-allocate significant amounts of its precious water and agricultural resources to feed the appetite of a new biofuels industry. Rather, it makes sense for Nevada to take the lead on developing an alternative biofuel feedstock that is more compatible with Nevada's need to manage the unique resources available in the Great Basin.

Traditional agricultural productions systems require a high quality of fresh water. The alternative halophytic algal production system being investigated here utilizes low quality waste water with preferably high salt content unsuitable for any other use.

In addition to abundance sunlight, Nevada has significant geothermal resources that could be leveraged to improve the economic viability of the proposed halophytic alga production systems. One of the major drawbacks of algal production systems investigated by the DOE in the mid 1990's was the nighttime cooling of production ponds that limited algal growth rates. Effective and strategic exploitation of geothermal resources for heating of algal production ponds would overcome this drawback.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

Rabbit Brush As A Multi-Use Industrial Crop For Biomaterial And Bioenergy Applications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Global warming and decreasing oil reserves have mandated the development of renewable and sustainable alternatives to petroleum-based products. Plants, which produce zero balance carbon emission energy feedstocks, represent a particularly attractive alternative to fossil fuels. Furthermore, due the high degree of chemical diversity present in plant kingdom, many plant species are being investigated as replacement for the production of petroleum-based industrial chemicals.

One such plant species is rabbit brush (Chrysothamnus nauseosus). Rabbit brush is a highly prolific perennial shrub that is endemic to Nevada and the Great Basin region of the United States. This plant species produces significant amounts natural rubber, soft resins and plant based ethanol. As such, while most plants are utilized for single applications, rabbit brush could be exploited for both the production of industrial materials (eg., rubber, plastics, coatings, lubricants and adhesives) and energy feedstocks (eg., biodiesel and cellulosic-based liquid fuels). The goal of this project is to examine the potential of Rabbit Brush As A Multi-Use Industrial Crop For Biomaterial And Bioenergy Applications.

What has been done
Over the past year scientist at the University of Nevada, Reno have developed a large scale methods of extracting rubber from rabbitbrush. This includes optimized solvent extraction methods (centrifugation and the use of creaming agents) to separate bulk rubber and resin from whole rabbitbrush plants. These methods have been able to consistently extract approximately 6% of total shrub dry weight as rubber and 5% as resin.

Molecular weight analysis of the extracted rubber reviewed that rabbitbrush rubber produces high quality rubber with an average molecular weight of 800,000 Daltons. Nuclear magnetic resonance analyses further showed that the solvent extracted rubber to be very pure with very little contaminating compounds.
Allergen analyses of rabbitbrush rubber shows that the proteins associated with rabbitbrush rubber particles have very low protein content. Although this finding bodes well for rabbit brush's potential as a hypoallergenic source of rubber, test are still necessary to determine if immunogenic proteins related to Type I latex allergies are present. Therefore we are in the process of performing analyses of rabbitbrush rubber particle proteins using antibodies to the major natural latex allergens Hev B1 and Hev B5.

Results

These accomplishments are important in that University of Nevada, Reno scientists have been able to generate materials that will allow the team to assess the biomaterial and bioenergy potential of materials extractor from rabbitbrush. Through these efforts the research team has validated the importance of rabbitbrush as one of the newest sources of locally grown rubber, resin and biomass materials in Nevada.

Thus far all results are indicating that Nevada's rabbit brush rubber is very comparable to another commercially grown plant from the US southwest, guayule. If more detailed analyses support these findings, it may be possible to utilize the currently established guayule industrial infrastructure to extract rubber, resin and biomass from rabbitbrush and thus establish a second commercial source of hypoallergenic rubber for the United States.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
511	New and Improved Non-Food Products and Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Competing Programmatic Challenges
- Other (Faculty seeking job security elsewhere)

Brief Explanation

Current State budget shortfalls will narrow the breadth of research programs in Nevada Agricultural Experiment Station (NAES). Fewer research projects will be supported and recruiting graduate students will be difficult. Plus, due to the Governor's hiring freeze, State budget shortfalls, and two department closures within the College of Agriculture, Biotechnology and Natural Resources, NAES is prevented from moving forward and determining the areas of research most important to the state, nation and internationally.

Current cutbacks to our programs will also affect how we determine the most important direction of the College/NAES to remain competitive with current research issues. Several of our senior faculty will be retiring and potential layoffs are looming, will cutbacks affect our ability to fill these positions or will we be forced to cutback our research efforts to concentrate on teaching our courses.

Additionally, if $17,000,000 is not secured by State Legislators this 2010 session, the College of Agriculture, Biotechnology and Natural Resources is proposed for closure and remaining departments will be moved to new homes. This action could significantly alter the NAES's organizational structure and cohesiveness.

All of these issues will determine the future of our research.

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Before-After (before and after program)
- During (during program)

Evaluation Results

Faculty programs are evaluated annually and annual reviews of performance are prepared for each calendar year. We held a web based mini-symposium to learn of the research advances from each NAES research projects where each principle investigator or graduate student makes a power point presentation in a forum open to all faculty, staff, students and stakeholders as well as College and NAES leadership. Faculty are questioned and future goals are discussed for each research project t in the NAES research portfolio. The web cast has been saved and will be open for review for one year. Faculty have been productive and continued to carry out cutting edge research and in addressing sustainable energy in Nevada.Where appropriate future funding will continue where the results justify continued funding.

Key Items of Evaluation

Publications in refereed journals, invited review articles, extension publications, invitations to talk at national and international meetings.