Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2011 Work Plan

Date of Status Update:
Date of Next Status Update: 12/1/2011
Date of Work Plan Approval: 6/23/2011
Project Completion Date: 6/30/2014 **Is this an amendment request?** _____

Project Title: Evaluation of Switchgrass as Biofuel Crop

Project Manager: Jim Eckberg
Affiliation: Central Lakes College
Address: 1830 Airport Rd
City: Staples **State:** MN **Zipcode:** 56479

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Location:

Counties Impacted: Statewide

Ecological Section Impacted: Lake Agassiz Aspen Parklands (223N), Minnesota and Northeast Iowa Morainal (222M), North Central Glaciated Plains (251B), Northern Minnesota and Ontario Peatlands (212M), Northern Minnesota Drift and lake Plains (212N), Northern Superior Uplands (212L), Paleozoic Plateau (222L), Red River Valley (251A), Southern Superior Uplands (212J), Western Superior Uplands (212K)

Total ENRTF Project Budget:		
	ENRTF Appropriation $:	120,000
	Amount Spent $:	0
	Balance $:	120,000

Legal Citation: M.L. 2011, First Special Session, Chp. 2, Art.3, Sec. 2, Subd. 06c

Appropriation Language:
$60,000 the first year and $60,000 the second year are from the trust fund to the Minnesota State Colleges and Universities System for Central Lakes College in cooperation with the University of Minnesota to determine the invasion risk of selectively bred native grasses for biofuel production and develop strategies to minimize the invasion potential and impacts on biodiversity. This appropriation is available until June 30, 2014, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Evaluation of Switchgrass as Biofuel Crop

II. PROJECT SUMMARY:

Native switchgrass has been selected and bred to establish dense, productive biofuel stands. This major advance in biofuel sustainability also poses a significant risk to native biodiversity; selectively bred switchgrass shares many characteristics that typify our most invasive species. Little is known about the invasion risk posed by selective breeding and hybridization of native grasses. Invasion risk assessment is urgently needed before high-yielding switchgrass cultivars are planted extensively for biofuel production in Minnesota. This information will support next generation biofuel by identifying specific switchgrass cultivars and management strategies to minimize invasion risk. We will integrate three focus areas:

- **Invasion Risk—** Little is known about the potential for improved switchgrass varieties to invade prairie and impact local biodiversity. We will evaluate invasion risk by comparing competitiveness of improved switchgrass cultivars versus a study control, local genotypes of switchgrass.
- **Risk Management—** We will develop recommendations for managing buffers to limit the spread of potentially invasive grass biofuel crops. We will evaluate mowing and buffers for managing switchgrass escapees; recommendations will balance effective control with management cost.
- **Biofuel Sustainability—** Invasion risk and impacts on native biodiversity is often overlooked as a critical consideration for biofuel crop sustainability. We will integrate information on invasion risk and biofuel production to determine the trade-offs associated with more productive but potentially more invasive biofuel crops.

III. PROJECT STATUS UPDATES:

Project Status as of December 2011:

Project Status as of July 2012:

Project Status as of December 2012:

Project Status as of July 2013:

Project Status as of December 2013:

Project Status as of June 2014:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Invasive Risk of Selectively Bred Switchgrass

Description:

Little is known about the invasion risk and impacts of switchgrass cultivars on native prairie plant diversity. We will conduct two separate studies to test the effect of switchgrass cultivars on prairie plant diversity in newly seeded prairies (Experiment 1) and established prairies (Experiment 2). Switchgrass cultivars will be compared to six locally native switchgrass populations (study control). This activity will occur in two locations at both the Ag and Energy Center of Central Lakes College in Staples, MN (Experiment 1) and Cedar Creek Ecosystem Science Reserve in East Bethel, MN (Experiment 2).

Seed:

In fall of 2011, we will collect switchgrass seed from 6 local native switchgrass populations within 100 miles of the Ag and Energy Center and Cedar Creek. We will minimize the risk of genetic contamination by non-local switchgrass in several ways. First, we will collect from large switchgrass populations that are surrounded by areas with well documented agricultural and planting history. Second, we will confirm that there are no known CRP plantings within 1 km of our collection. Our standards exceed the rigor of current Minnesota Crop Improvement Agency standards for verifying origin-identified (yellow tag) native plant material for use in prairie restorations (MCIA 2010). Further, any potential contamination will likely be small and/or diluted by large local switchgrass populations.

We will focus on three switchgrass cultivars. An evaluation of switchgrass cultivar establishment, underway in 2010 and 2011, will be used to refine the final list of cultivars to focus on a suite that differs in productivity and potential invasiveness. This could lead to recommendations for selecting cultivars that produce high biomass yields while minimizing invasion risks.

Using seed from the same three cultivars and six locally native populations of switchgrass we will conduct experiments on invasion risk and impacts in newly seeded (experiment 1) and established prairie (experiment 2)

In experiment 1, we will use MnDOT seed mixture 350 (includes grasses and forbs) to establish a mixture of prairie species. This mixture is established widely across the state for prairie restorations. Switchgrass seed will be assigned to one of six seed densities (see below). Seed will be cold stratified in the winter prior to seeding in spring 2012.

Experiment 1 Design:

This study will involve a full factorial of the treatments: Cultivar (3 types) versus locally native switchgrass (6 types) (9 total, referred from here on as "switchgrass types") and 6 seed densities (25, 50, 100, 150, 250, and 350 seeds/ m^2). Four m^2 plots of each switchgrass type and seed density will be established in the spring of 2012. Switchgrass seed will be incorporated with the MnDOT seed mixture 350 and be distributed evenly over each plot. Seed will be raked into the top 1 cm of soil to improve seed-to-soil contact and simulate conventional seed drilling techniques used to restore prairies. As a part of conventional management for newly seeded prairies, we will perform two to three herbicide treatments prior to seeding and we will control annual weed cover using a combination of mowing, hand-weeding and/or clipping during both years of the study (2012-2013).

We will replicate cultivar (3 types) vs. non-cultivar (6 types) plots at a 2:1 ratio. This will allow for more power to detect differences between specific cultivars whereas non-cultivars are considered random samples of a larger pool; therefore, we increase the number of native switchgrass populations versus replication within each population. The experimental design will be repeated in two sites (72 plots/ site; 144 plots total) at the Ag and Energy Center.

Measurements:

In the first year of establishment (2012), we will harvest above-ground plant material in a 0.5 m^2 subplot within each 4 m^2 plot to determine the biomass of each species. Biomass will be collected at the end of the growing season and before senescence to allow for identification and sorting of species. In year 2 (2013, post-establishment) we will repeat the same measurements. Our response variables for switchgrass are biomass (percent switchgrass biomass). Our response variables for the entire plant community-plot are species richness and percent composition. We will use these data to calculate diversity indices for each plot.

Statistical Analysis:

This study will be analyzed with a linear mixed effect model. Cultivar versus locally native switchgrass will be treated as fixed effects whereas each locally native switchgrass population (6) will be treated as random effects. Locally native switchgrass populations represent random samples of a larger statistical population (central Minnesota) thereby satisfying the requirements of a random effect. In contrast, each switchgrass cultivar will be treated as a fixed effect because information on selected growth characteristics of each cultivar will allow for specific, testable predictions of invasiveness among cultivars. This analysis will allow us to make specific inferences regarding the invasiveness of each cultivar. Our design includes more experimental units for each cultivar to improve statistical power to detect differences among cultivars. Site will be considered a random effect.

Seed density will be analyzed as a continuous fixed effect. We have chosen a wide range of seed inputs for several reasons. First, because a mixed model compares the slope and intercepts of a line fit to the data, added data along the line is a better use of experimental units as compared to more data at each point along the line. Second, this approach will shed more light on the relationship between arriving seed number and switchgrass dominance. A single seed level experiment could miss critical insight; the impacts of switchgrass cultivars are likely to vary with seed input and density dependence. Using Akaike's information criterion, we will test the fit of competing models that describe the shape of the curves.

Experiment 2 Design:

As in experiment 1, experiment 2 will involve a full factorial of the treatments (fixed effects): Cultivar versus locally native switchgrass (9 total types) and 6 seed densities (25, 50, 100, 150, 250, and 350 seeds/ m^2). Four m^2 plots of each switchgrass type and seed density will be established in two established prairies during the spring of 2012. The experimental design will be replicated within two sites (144 plots/ site; 288 plots total) at Cedar Creek. If the study is not conducted at Cedar Creek, we will use a suitable alternative location.

Seeding and plot establishment methods will mimic a seed dispersal event into an established prairie. Therefore, in contrast to experiment 1, we will evenly distribute the seeds over each plot but we will not rake the seeds into the soil. Ideally we will establish the plots in fall 2011. However, seed collection will also occur in September and October of 2011; therefore, an early snowfall may prevent seeding in fall 2011. If seeding is postponed until spring 2012, seeds will be cold stratified during the winter.

This study will be analyzed using the same model structure as in experiment 1, a linear mixed effect model.

Measurements:

In the first year of establishment (2012), we will harvest above-ground plant material in randomly selected 0.5 m^2 subplots (within each 4 m^2 plots) and determine the biomass of switchgrass and other prairie species. Biomass will be collected at the end of the growing season and before senescence to allow for identification and sorting of species. In year 2 (2013, post-establishment) we will repeat the same measurements in a different randomly selected subplot. Our response variables for the entire plant community-plot are species richness and percent composition. We will use these data to calculate diversity indices for each plot.

Summary Budget Information for Activity 1: **ENRTF Budget: $ 95,000**

Amount Spent: $ 0
Balance: $ 95,000

Activity Completion Date:

Outcome	Completion Date	Budget
1. Collect seed from remnant switchgrass populations	November 1, 2011	$7,000
2. Establish and maintain experimental plots and treatments	September 15, 2013	$43,000
3. Collect, process and analyze data (2012-2013 growing seasons)	February 1, 2014	$38,000
4. Submit manuscript(s) to peer-reviewed journals	June 1, 2014	$7,000

Activity Status as of December 2011:

Activity Status as of July 2012:

Activity Status as of December 2012:

Activity Status as of July 2013:

Activity Status as of December 2013:

Activity Status as of June 2014:

Final Report Summary:

ACTIVITY 2: Invasion Risk Management

Description:

We will test two strategies for controlling switchgrass cultivars: mowing and buffer composition. These two studies will occur at the Ag and Energy Center of Central Lakes College in Staples, MN.

Mow Treatments:

We will test the efficacy of mowing to control switchgrass cultivars. Mow treatments will involve cutting established stands of Forestburg switchgrass to a height of 5-10 cm. Through a Next Gen grant, one acre plots of Forestburg switchgrass were established at the Center in 2009. Within each of these large plots we will establish small (4 m^2) mowing treatment plots. Within each switchgrass stand, we will assign the following three treatments: no mow (control), mowed in early summer, mowed in late summer, and mowed in both early and late summer. Mowing times are designed to target specific life history stages: early summer and late summer mowing removes basal and flowering stalks (plus basal leaves), respectively. Consecutive within-season mowing has been shown to reduce switchgrass vigor (Cuomo, Anderson et al. 1998) but the potential for mowing to reduce invasiveness remains less clear. This experiment will be replicated in three switchgrass stands (12 total experimental units). We will perform these treatments in 2012.

Mowing Measurements:

We will measure height and biomass of switchgrass in the spring of 2013 for 0.5 m^2 subplots within each plot to assess the effects of mowing treatments in 2012 on subsequent regrowth in 2013. A final measurement of switchgrass biomass will be collected after senescence in the fall of 2013. The data will be analyzed with ANOVA.

Buffer Treatments:

We will test the effect of aspen (*Populus tremuloides*) windrows in preventing the spread of switchgrass cultivars. Aspen was selected as the windrow species because it is fast-growing and common in north-central Minnesota. Our windrow consists of three rows of trees, 6 meter width, and 20 meter height. For this study, the windrow will be located to the east of the plots. Future research will test windrows located to the north, south, and west of plots.

Three switchgrass cultivars will be planted in four m^2 plots (250 seeds/ m^2) during the spring of 2012 at varying distances from the edge of the aspen windrow (8 meters, 2 meters, windrow edge, and 2 meters into the windrow). We will control weeds in these plot areas prior and after seeding to isolate the direct effect of the windrow on switchgrass growth. By varying planting distances in relation to the windrow we intend to mimic a dispersal event of seeds into the windrow, and test the capacity of windrows to suppress the establishment and spread of switchgrass. The same three cultivars used in activity #1 will be used in this study. Each set of distances will be replicated four times per switchgrass cultivar (3 cultivars X 4 distances X 4 replications = 48 experimental units). This simple design will allow us to evaluate the efficacy of windrow buffers in minimizing switchgrass cultivar spread via seed dispersal.

Buffer Measurements:

In the first year of establishment (2012), we will measure establishment as the biomass of switchgrass harvested in 0.5 m^2 subplots at the end of the growing season. In fall of 2013 we will harvest senesced switchgrass in a different randomly selected subplot. We will evaluate the impacts of the windrow by regular measurements of light penetration across the season and in relation to distance to the windrow. The data will be analyzed with ANOVA.

Activity Completion Date:

Outcome	Completion Date	Budget
1. Establish and maintain experimental plots and treatments	September 15, 2013	$17,500
2. Collect, process and analyze data (2012-2013 growing seasons)	February 1, 2014	$6,900
3. Submit manuscript to peer-reviewed journal	June 1, 2014	$600

Activity Status as of December 2011:

Activity Status as of July 2012:

Activity Status as of December 2012:

Activity Status as of July 2013:

Activity Status as of December 2013:

Activity Status as of June 2014:

Final Report Summary:

V. DISSEMINATION:

Description:
Results and recommendations from this study will be disseminated to farmers and conservation, industry, university, and government organizations through the following outlets:

- Field demonstration days are conducted annually in August. Tours of the plots will be conducted to discuss our experimental research and implications for biofuel production and natural areas.

- Annual updates of our research will be provided through the Center's website (http://www.clcmn.edu/agcenter/index.html).

- Seminars and presentations will be given for the Minnesota DNR, Ecological Society of America, the University of Minnesota and other potential Universities and/or government agencies.

- Publishable results from this research will be submitted to peer-reviewed journals.

Status as of July 2012

Status as of December 2012

Status as of August 2013

Status as of December 2013

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget:

Budget Category	$ Amount	Explanation
Personnel:	$ 96,859	**Robert Schafer** - Supervisor - Agricultural and Energy Center within Central Lakes College. Responsible for managing the budget and expenses for this grant (MNSCU); contribute to experimental plot set-up and management; oversee outreach effort. Annual Salary $65,156 plus fringe $16,289 x 0.03 FTE = $2,443 x 3 years **(total = $7,330).** **Ron Nelson** - Farm Manager - Agriculture and Energy Center within Central Lakes College. Contribute to experimental site selection, preparation, and plot management. Annual Salary $37,547 plus fringe $9,387 x 0.06 FTE = $2,816 x 3 years **(total = $8,448).** **Undergraduate Interns** - University of Minnesota and Central Lakes College. Establish and maintain plots, collect and process data samples. 4000 total hours @ $11 / hr **(total = $44,000).** **Graduate Student** - University of Minnesota. Coordinate experimental plot establishment, plot maintenance, data collection and processing. Annual Salary $20,717 plus fringe $16,838 x 0.3 FTE = $11,267 x 2 years **(total = $22,534).** **Shelby Flint** - Graduate Student - University of Minnesota. Refine experimental protocol; oversee plot establishment, data collection and processing; analyze and interpret data; write and submit manuscripts. Annual Salary $20,717 plus fringe $16,838 x 0.32 FTE **(total = $12,017).** **Matt Bickel** - Lead Technician - University of Minnesota. Provide GIS expertise to locate remnant switchgrass populations. Annual Salary $36,122 plus fringe $14,485 x 0.05 FTE **(total = $2,530).**
Equipment/Tools/Supplies:	$5,211	**Supplies:** Switchgrass and prairie seed mixture (480 experimental plots) **(total = $2,500)**. **Supplies to:** establish plots (ie tape meters, rakes, herbicide, etc.), maintain plots (ie scissors, gloves, surveyor flags, metal tags), assist in seed organization (ie. envelopes), and collect and process data (ie. notebooks, meter sticks) **(total = $1,661)**. **Equipment Use:** Fuel and maintenance expenses for spraying, tractor, and brush cutter equipment used to establish and maintain plots **(total = $1,050)**.
Printing:	$500	Printing for annual agriculture field days and other demonstrations
Travel Expenses in MN:	$14,430	Travel from Saint Paul to Staples and Cedar Creek research plots; lodging and food reimbursements associated with travel to Staples (Expenses adhere to UMN travel expense policy). (Activity 1: 18,000 total miles X $0.51/mile = $9,180, lodging and food reimbursements = $2,720. Activity 2: 3,000 miles X $0.51/mile = $1,530, lodging and food reimbursements = $1,000)
Other: Soil Analysis	$1,500	Soil Analysis @ Soil Testing Lab, Crops Research Building, University of Minnesota. (ie. Analysis of one sample for total nitrogen and organic carbon, pH, potassium, phosphate and total phosphorus = $61 x 24 samples = $1464)

Other: Publication Costs	$1,500	Peer-reviewed Journal Publication Cost (ie. Ecological Society of America charges $75/printed page X 6-8 pages per article = $600/ publication)
TOTAL ENRTF BUDGET:	**$120,000**	

Explanation of Use of Classified Staff: Robert Schafer and Ron Nelson are classified staff. However, they are not provided with an annual, regular salary from the state. Their salary is generated from on-farm and activities such commodity production and grants (soft money).

Explanation of Capital Expenditures Greater Than $3,500: N/A

Number of Full-time Equivalent (FTE) funded with this ENRTF appropriation: 2.98 FTE

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$0	$0	
State			
	$0	$0	
TOTAL OTHER FUNDS:	**$0**	**$0**	

VII. PROJECT STRATEGY:

A. Project Partners:

Partners Receiving Funds from the ENRTF appropriation:

Robert Schafer (Supervisor – Agriculture and Energy Center, Central Lakes College) **$7,330**
Shelby Flint (Graduate Student – University of Minnesota) **$12,017**

Robert Schafer will serve as co-project manager. He will manage the budget and expenses for this grant (MNSCU), contribute to experimental plot establishment and weed management, and he is responsible for outreach and dissemination of information to the agricultural community. Shelby Flint will refine and adapt the experimental protocols, oversee plot and treatment establishment, data collection and analysis as well as prepare research results for publication in peer-reviewed journals. Shelby will provide two years (@ 0.15 FTE) in-kind service and she will be partially supported with funds from the ENRTF appropriation for one year (0.32 FTE).

Partners Providing In-Kind Services:

Shelby Flint (Graduate Student – University of Minnesota) **0.15 FTE x 2 years**
Jim Eckberg (Graduate Student – University of Minnesota) **0.15 FTE x 3 years**

Jim Eckberg will serve as co-project manager and he will partner with Shelby Flint to lead this study. They will refine and adapt the experimental protocols, oversee plot and treatment establishment, data collection and analysis as well as prepare research results for publication in peer-reviewed journals. Shelby Flint and Jim Eckberg will provide in-kind services for two and three years, respectively.

University of Minnesota Partners Providing Advisory Services:

Neil Anderson (Associate Professor, Horticultural Science)
Gregg Johnson (Associate Professor, Agronomy and Plant Genetics)

Nicholas Jordan (Professor, Agronomy and Plant Genetics)
Ruth Shaw (Professor, Ecology, Evolution and Behavior)
Craig Sheaffer (Professor, Agronomy and Plant Genetics)
Donald Wyse (Professor, Agronomy and Plant Genetics)

Our team of agronomists and ecologists from the University of Minnesota will provide guidance and input on the refinement of research protocols, data analysis, and research manuscripts resulting from this grant. Our group has expertise in agronomy and biofuel production, plant breeding, and ecology and we are unified by the central goal of developing productive biofuel systems that do not threaten the state's native biodiversity.

B. Project Impact and Long-term Strategy:

High-yielding grasses provide new opportunities for sustainable biofuel production on marginal lands. However, there is increasing concern that these fast-establishing grasses may invade and impact natural areas. This research will provide one of the first invasion risk assessments of biofuel crops in Minnesota; such information is central for breeders, conservationists, and agronomists working to expand biofuel production without causing large-scale plant invasions in natural areas. Thus we have assembled a team a faculty members with expertise spanning agronomy, plant breeding and ecology.

At the core of this project is the Energy and Agricultural Center of Central Lake College in Staples, Minnesota. The Center is working to develop a community-based and sustainable biofuel industry for the Central Sand Plains. In 2009, the Center secured a Next Gen grant to evaluate the production of perennial grasses, including Miscanthus x giganteus and switchgrass. The current LCCMR is a direct extension of the Next Gen grant and will allow us to evaluate invasive potential of switchgrass at the Center. We are currently pursuing federal funds to expand and extend the LCCMR-funded research. In particular we intend to quantify dispersal distance and the dispersal kernel of switchgrass seeds. Contingent on federal funding we will construct spread-impact models for switchgrass as well as continue monitoring our plots to track long-term changes in prairie diversity and productivity.

C. Spending History:

Funding Source	M.L. 2005 or FY 2006-07	M.L. 2007 or FY 2008	M.L. 2008 or FY 2009	M.L. 2009 or FY 2010	M.L. 2010 or FY 2011
	$0	$0	$0	$0	$0

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. MAP(S): N/A

X. RESEARCH ADDENDUM: See Research Addendum (Revised May 2011)

XI. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted not later than December 15, 2011, July 15, 2012, December 15, 2012, July 15, 2013, December 15, 2013, and June 15, 2014. A final report and associated products will be submitted between June 30 and August 1, 2014 as requested by the LCCMR.

Attachment A: Budget Detail for M.L. 2011 (FY 2012-13) Environment and Natural Resources Trust Fund Projects

Project Title: Evaluation of Switchgrass as Biofuel Crop
Legal Citation: Pending
Project Manager: Robert Schafer and Jim Eckberg
M.L. 2011 (FY 2012-13) ENRTF Appropriation: $120,000
Project Length and Completion Date: June 2014
Date of Update: June 2014

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Balance	Activity 2 Budget	Amount Spent	Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Invasion Risk and Impacts of Selectively Bred Switchgrass***			***Invasion Risk Management***				
Central Lakes College and University of Minnesota Personnel	***76500***	***0***	***76500***	***20359***	***0***	***20359***	**96859**	**96859**
Personnel: Robert Schafer - Supervisor - Agricultural and Energy Center within Central Lakes College, Responsible for managing the budget and expenses for this grant (MNSCU); contribute to experimental plot set-up and management; oversee outreach effort. Annual Salary $56,523 plus fringe $24,916 x 0.03 FTE = $2443 x 3 years **(total = $7,330)**.		***0***			***0***			
Personnel: Ron Nelson - Farm Manager - Agriculture and Energy Center within Central Lakes College. Contribute to experimental site selection, preparation, and plot management. Annual Salary $27,266 plus fringe $19,670 x 0.06 FTE = 2816 x 3 years **(total = $8,448)**.		***0***			***0***			
Personnel: Undergraduate Interns - University of Minnesota and Central Lakes College . Establish and maintaining plots; collect and process data samples. 4000 total hours @ $11 / hr **(total = $44,000)**.		***0***			***0***			
Personnel: Graduate Student - University of Minnesota . Coordinate experimental plot establishment, plot maintenance, data collection and processing. Annual Salary $20,717 plus fringe $16,838 x 0.3 FTE = $11,267 x 2 years **(total = $22,534)**.		***0***			***0***			
Personnel: Shelby Flint - Graduate Student - University of Minnesota. Refine experimental protocol; oversee plot establishment, data collection and processing; analyze and interpret data; write and submit manuscripts. Annual Salary $20,717 plus fringe $16,838 x 0.32 FTE **(total = $12,017)**.		***0***			***0***			
Personnel: Matt Bickel - Lead Technician - University of Minnesota. Provide GIS expertise to locate remnant switchgrass populations. Annual Salary $36,122 plus fringe $14,485 x 0.05 FTE **(total = $2,530)**.		***0***			***0***			
Supplies: Switchgrass and prairie seed mixture (480 experimental plots)	***2,000***	***0***	***2,000***	***500***	***0***	***500***	**2500**	**2500**
Supplies: Various Supplies to: establish plots (ie. tape meters, rakes, herbicide, etc.), maintain plots (ie. scissors, gloves, surveyor flags, metal tags), assist in seed organization (ie. envelopes, bags), and collect and process data.	***1,500***	***0***	***1,500***	***161***	***0***	***161***	**1661**	**1661**
Equipment Use: Fuel and maintenance expenses for spraying, tractor, and brush cutter equipment used to establish and maintain plots	***800***	***0***	***800***	***250***	***0***	***250***	**1050**	**1050**
Printing - Annual Agriculture field days and other demonstrations	***400***	***0***	***400***	***100***	***0***	***100***	**500**	**500**
Travel expenses in Minnesota - Travel from Saint Paul to Staples and Cedar Creek research plots; lodging and food reimbursements associated with travel to Staples (Expenses adhere to UMN travel expense policy). (**Activity 1**: 18,000 total miles X $0.51/mile = $9,180, lodging and food reimbursements = $2,720. **Activity 2**: 3,000 miles X $0.51/mile = $1,530, lodging and food reimbursements = $1,000)	***11,900***	***0***	***11900***	***2,530***	***0***	***2,530***	**14430**	**14430**
Other: Peer-reviewed Journal Publication Cost (ie. Ecological Society of America charges $75/printed page X 6-8 pages per article = $600/ publication)	***900***	***0***	***900***	***600***	***0***	***600***	**1500**	**1500**
Other: Soil Analysis @ Soil Testing Lab, Crops Research Building, University of Minnesota (ie. Analysis of one sample for total nitrogen and organic carbon, pH, potassium, phosphate and total phosphorus = $61 x 24 samples = $1464)	***1,000***	***0***	***1,000***	***500***	***0***	***500***	**1500**	**1500**
COLUMN TOTAL	**$95,000**	**$0**	**$95,000**	**$25,000**	**$0**	**$25,000**	**$120,000**	**$120,000**