

Division of Marketing  
Agricultural Development and Diversification (ADD) Program  
1994 Grant Final Report

Grant Number 09038

**Grant Title** Evaluation of the Feasibility of Establishing an Energy Crop Program  
for an Electrical Generation Program

**Amount Awarded** \$15,000.00

**Name** Conrad Anderson

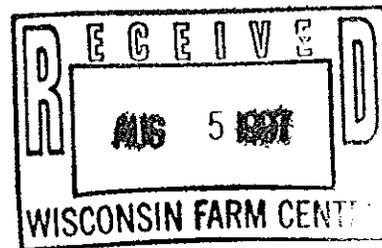
**Organization** Biotech Energy Corporation  
Mt. Horeb

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Biotech Energy Corp.  
8757 Bakken Road  
Mt. Horeb, WI 53572



August 22, 1997

Mr. Mike Bandli  
DATCP - ADD  
P.O. Box 8911  
Madison, WI 53708-8911

Subject: Submittal of Final Report and Final Invoice

Dear Mike:

Please find enclosed a copy of the Final Report describing the results of our Evaluation of the Feasibility of Establishing an Energy Crop Program for an Electrical Generation Project, dated May 30, 1997 and submitted by PowerGrass Purveyors, LLC. I believe the results of the investigation carried out by PowerGrass Purveyors and co-funded by DATCP-ADD will be valuable to closed-loop biomass project developers as the energy crop industry emerges in the Midwest over the next few years. With these results, project developers will be better able to design a switchgrass establishment program for any given project that utilizes significant quantities of farm-grown switchgrass. The enclosed report prepared by PowerGrass Purveyors does a satisfactory job of summarizing the results of this important multiyear investigation.

Also enclosed is the Final Invoice issued by PowerGrass Purveyors in the amount of \$1225.50 and dated August 14, 1997. If you have any questions regarding this invoice please call me at (608) 833-6575.

Since this Final Report is the last task in our project, I would like to take this opportunity to thank you and your associated at DATCP-ADD for your patience in accepting project delays as they have inevitably occurred over the years and for your support without which this important research would not have been accomplished.

Sincerely,

Biotech Energy, Corp.

A handwritten signature in cursive script that reads "Conrad Anderson".

Conrad Anderson  
President

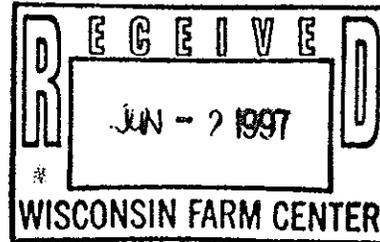
cc: Tim Baye, PGP, LLC  
Stuart Urban, PGP, LLC

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PowerGrass Purveyors, LLC

May 30, 1997

Mike Bandli  
DATCP-ADD  
P.O. Box 8911  
Madison, WI 53708-8911



Dear Mike:

Here is the final summary report. We will be sharing the economics (cost/dry ton) as soon as we harvest this autumn. We will also send our "best management report" and the Council of Great Lakes Governors' report to you as well. Hope things are going well. Take care.

Sincerely,



Timothy M. Baye  
Member

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PowerGrass Purveyors, LLC

May 30, 1997

Mike Bandli  
DATCP-ADD  
P.O. Box 8911  
Madison, WI 53708-8911

Final Report: Agricultural Development & Diversification Project: Evaluation of the Feasibility of Establishing an Energy Crop Program for an Electrical Generation Project

Prepared For: Conrad Anderson, President, Biotech Energy Corporation.  
8757 Bakken Rd., Mt. Horeb, WI 53572

#### Project Summary

This project was conducted in support of Biotech Energy Corporation's (BEC) efforts to evaluate the feasibility of establishing a renewable fuel fired power plant in Southwestern Wisconsin. BEC's project intended to incorporate the acquisition of a recently closed 50 MW nominal coal fired power plant, EJ Stoneman Power Plant - Cassville, Wisconsin (Stoneman). BEC intended to investigate converting Stoneman's combustion systems to a dedicated biomass boiler system and to investigate the establishment of a fuel crop supply system. BEC contracted with PowerGrass Purveyors, LLC (PGP) to conduct the study of the establishment of the fuel crop supply system.

PGP's research focused on investigating the potential of producing switchgrass as a fuel crop. Switchgrass is a perennial, native tall-grass prairie grass. Switchgrass's potential as a biofuel had been researched by the U.S. Federal Laboratory in Oak Ridge, Tennessee for a number of years and was considered as a potential crop for production on marginal/highly erodible cropland. PGP's research intended to investigate the ability of existing farmers' capabilities to determine the most appropriate cultivation practices, field/soil characteristics and harvesting practices to maximize the BTU value per ton of combustible switchgrass biomass. PGP's research was to also evaluate the producer economics, evaluate land availability, estimate net yields, identify key agronomic risks and provide the basis for the development of a business plan for the establishment of a fuel crop procurement company.

## Research Results

The principal focus of this research is to develop a commercial biomass production database and business strategy. Key to this effort is the research design. The study intended to determine the ability of existing commercial farmers to effectively establish switchgrass stands using existing implement equipment and the farmer's knowledge of agronomy and their land. Eleven farmers were recruited for participation in this project.

Approximately 47 acres of switchgrass were planted during the years of 1994 and 1995. Technical agronomic assistance was kept minimal: 1) single site visit by an agronomist (Neil Diboll, President, Prairie Nursery, Inc.); 2) single instructional meeting; and 3) written technical material and data sheets. Production results were expected to reflect variations among participants.

A delay in the notification of receipt of funding (June, 1994) precluded our efforts to plant a significant amount of the switchgrass acreage in 1994. Only Charles Christianson's 2.0 acres (Cobb, WI) was successfully planted in 1994. The remaining acreage was secured and planted in 1995.

The results of the majority of the DATCP-ADD plantings were less than encouraging from the perspective of identifying "commercially viable" methods of establishing switchgrass as a crop. A wide variety of field preparation methods (conventional tillage-with herbicide, conventional tillage-without herbicide, no-till on previous row crop fields, no-till on previous pasture/CRP fields) were adopted. Likewise, both broadcasting and drill seeding planting approaches were tried. Some fields were planted with cover crops (oats and barley), others were planted without cover crops.

Some sites were carefully monitored and managed. These sites were clipped in mid-1995 to remove weed seedheads. Others were left to grow without any additional management practices.

The attached grower profiles provide a more complete summary of the various preparation, planting and management practices for each test plot and farmer.

Only two sites of the twelve planted stand out as reasonable successes, with respect to establishment of a viable switchgrass stand: Charles Christianson's 1995 planting and Tom Gildersleeve's 1995 planting. Both of these sites demonstrated healthy stand development and weed control. Christianson's stand was far and away the most encouraging stand. After two growing seasons this stand was uniformly dense (~15 to 20 plants/sq. meter), had excellent plant growth (3-5 ft. as of 10/96) and excellent seedhead development (greater than 50% of all plants).

Gildersleeve's stand did not exhibit the plant density or growth of Christianson's, yet switchgrass

was the dominant plant apparent in the field. One of the more telling attributes of Gildersleeve's stand was the irregular distribution of switchgrass plants/rows. Our interpretation of this distribution was that the seed drill was only depositing the switchgrass seed into the "germinating zone" of the soil every-other row. This interpretation proved to be especially beneficial for planning and planting our test plots in 1996 (Counsel of Great Lake Governor's Regional Biomass Program: CGLG-95-013).

Results generated by the Rich Lange, Al Neises, Bill Neises, Bill Brandt, Dennis Fritz and Prof & Doc Farms, LLC stands taught us a great deal about what not to do when attempting to establish a viable switchgrass stand. All of these test plots suffered from one or more of the following:

1. Poor seedbed preparation. Too much crop residue remaining on soil for adequate placement of seed into "germination zone" (clogging of seed drill)
2. Poor/inadequate attention to clogging of seed drill, either by too many seeds dropping or by clogging of drill by soil;
3. Inadequate/insufficient use of herbicide to kill existing/emerging weeds prior to planting.
4. Inadequate or poorly timed post planting weed control (clipping) practices.

The Gildersleeve and Christianson stands provided insight into practices which promoted good-to-adequate stand establishment, including:

1. Careful seedbed preparation, through conventional tillage (multiple passes with disk and/or harrow);
2. Well timed application of herbicide prior to planting; and,
3. Planting with sufficient soil temperature and moisture (key issue).

While Gildersleeve's stand experienced switchgrass densities at the end of the second year of growth (1996) of approximately 5 plants per square meter, Christianson's 1995 planting generated much better densities (7-12 plants per square meter), plant growth (~ 4 feet in height/plant) by October, 1996 and greater than 75% seed head development. Christianson's 1995 planting would have represented a commercially viable stand for biomass harvest in the second year of establishment, should an application (market) for the biomass existed. We anticipate generating accurate biomass yield data (dry tonnage) from a sample harvest of this stand in October, 1997 - the third year of establishment.

## **Application of DATCP-ADD Research to PGP's Council of Great Lakes Governor's Research**

Based upon our experiences in switchgrass stand establishment with the DATCP-ADD research, we revised much of our study protocol for the Council of Great Lakes Governor's Research (CGLG) scheduled for planting in 1996. Two general approaches were pursued in this research:

1. Experimentation with planting switchgrass in prior row crop land, using extensive conventional tillage, with (eg. Gildersleeve), and without herbicide weed control (eg. Christianson & Lange).. These stands were to also use both conventional seed drills and cover crops.
2. Experimentation with planting switchgrass in prior fallow (eg. CRP) land using fire, herbicide and no-till drilling. The fire-herbicide site preparation method was designed to attempt to address many of the problems experienced in the Prof & Doc, Fritz and Bill Neises DATCP-ADD sites.

Profiles of the first year results of this research are attached. Our 1997 planting will attempt to reproduce the success experienced in the 1996 Houtakker and Prof & Doc CGLG stands. Organic (non-herbicide), mechanical only seed bed preparation is not being pursued in this final year of CGLG research. Additionally, a mowing-herbicide seedbed preparation method, with no-till drill planting for fallow land will also be attempted in 1997.

### **Further Research**

A number of significant issues remain unaddressed in our research, as well as within the entire herbaceous biomass propagation, production and use field. The following are issues we hope to address within the next two-to-three years:

1. Identification of which switchgrass genotypes are best suited for early site establishment and plant growth;
2. Development of switchgrass planting, management and harvesting "best management practices" guide for use by conventional, commercial farmers;
3. Biomass yield and cost per ton (both annual and life cycle) estimates for both conventional and no-till planting methods;
4. Experimentation with switchgrass seed harvesting (combining) from both our DATCP-ADD and CGLG test plots. Included in this effort will be an analysis of the plant density variations and subsequent yield differences between test plots from which seed was harvested, versus those plots which were allowed to re-seed.

## Research Projects Status Report

February 3, 1997

### Biotech Energy Corp./Wis. Dept. Agriculture: Ag. Development & Diversification Project: **Grower Profiles**

**Grower:** Bill Brandt - Potosi, WI  
**Acres:** 3.5, loam  
**Previous Crop Use:** Sudax, '94; Corn, '93-92  
**Date Planted:** 05/20/95  
**Site Preparation:** chisel plow, soil finisher, rotar  
**Herbicide:** none  
**Fertilizer:** Manure, 7,000#/acre, 10/94  
**Cultivar:** Blackwell  
**Application Rate:** 8#/acre  
**Equipment:** J.D. Drill, alfalfa setting

**Comments:** Heavy growth of various plants when observed on July 14, 1995. Unable to determine switchgrass germination and plant establishment success. Field clipped in autumn 1995 for forage. October, 1995 visit did not provide much additional information due to close clipping for forage. August, 1996 visit again showed much biomass but unable to determine switchgrass establishment due to competing weeds (e.g. wooly cup plant and rye). Did not visit in autumn, 1996.

**Next Action:** Visit site in late winter/early spring, 1997 to determine switchgrass presence and to define 1997 management tactics. Attempt to gain rental extension for at least 1997.

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**1997 Grower Profiles continued**

**Grower:** Charles Christianson, Cobb, WI  
**Acres:** 2.0, loam?  
**Previous Crop Use:** Pasture, Corn and Alfalfa  
**Date Planted:** 06/95  
**Site Preparation:** rotar, 3 passes  
**Herbicide:** none  
**Fertilizer:** none  
**Cultivar:** Cave-in-Rock  
**Application Rate:** 8#/acre  
**Equipment:** Brillion No Till Drill, alfalfa setting

**Comments:** Did not visit site during 1995. Clipped by Charlie in May, 1996. Visited site August 7, 1996. One of best test plots in our group. High and uniform density of plants. Plants 2-4' high and producing seed heads. Primary competition: Queens Annes Lace and Canadian Thistle. Visited again October, 1996. 50%+ seed head production.

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

**Grower:** Charles Christianson, Cobb, WI  
**Acres:** 2.0, loam?  
**Previous Crop Use:** Pasture  
**Date Planted:** 06/27/94  
**Site Preparation:** rotar, 3 passes; plow, harrow  
**Herbicide:** Roundup  
**Fertilizer:** none  
**Cultivar:** WI DNR (Blackwell ?)  
**Application Rate:** ?  
**Equipment:** WI DNR planter (Tom Howard)

**Comments:** Site appeared to experience good plant establishment in 1994. Clipped and cut during 1995. Switchgrass appeared to suffer during 1995. Weed competition. Clipped and baled June, 1996. Visited site 08/07/96. Clumps of switchgrass without uniform distribution. Much fescue, timothy and orchard grass.

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

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**1997 Grower Profile continued**

**Grower:** Tom Gildersleve, Fennimore, WI  
**Acres:** 4.8, loam  
**Previous Crop Use:** Corn, '94-92  
**Date Planted:** 06/18/95  
**Site Preparation:** chisel, disk  
**Herbicide:** Roundup, 3%, Atrazine & Oil, 1.5#/acre  
**Fertilizer:** none  
**Cultivar:** Trailblazer  
**Application Rate:** 8#/acre  
**Equipment:** Great Plains No Till Drill, alfalfa setting

**Comments:** Visited site 07/14/95. Nearly no biomass of any kind. Visited site again October, 1995. Few switchgrass plants, some with seedheads. 12-24" tall. Visited site 08/07/96. Recently clipped. Plants that missed clipping looked very robust and were producing seed heads. Visited site 10/09/96. Heavy foxtail infestation. Fair switchgrass density (~15% of planted seeds), but not uniform. One of planting drill appears not to have been distributing seed (missing rows)

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

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**1997 Grower Profiles continued**

**Grower:** Richard Lange  
**Acres:** 3.0, fayette silt loam  
**Previous Crop Use:** Corn and Alfalfa  
**Date Planted:** 06/10/95  
**Site Preparation:** rotar, 3 passes & disk  
**Herbicide:** none, no chemical use on field since 1989  
**Fertilizer:** none  
**Cultivar:** Cave-in-Rock, oats cover crop  
**Application Rate:** 8#/acre  
**Equipment:** Vanbrunt(?) Drill, alfalfa setting

**Comments:** Visited site 07/1495. Oats looked great. We mistook wooly cup plant for switchgrass. In retrospect, unable to determine switchgrass plant establishment during that visit. Clipped by Rich in late summer, 1995. Visited site August 7, 1996. High density of wooly cup plant and rye. Good, uniform density of switchgrass plants. Plants 1.0-1.5' high and producing some seed heads. Appeared to be recently clipped

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

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**1997 Grower Profiles continued**

**Grower:** William Neises, Neises Farms, Bloomington, WI  
**Acres:** 2.4 & 2.5  
**Previous Crop Use:** Corn and Alfalfa  
**Date Planted:** 06/03/95  
**Site Preparation:** disk on buffer strip, none on previous corn ground  
**Herbicide:** Round-up, Atrazine '94 or '93  
**Fertilizer:** none  
**Cultivar:** Cave-in-Rock & Trailblazer  
**Application Rate:** 8#/acre  
**Equipment:** Great Plains No Till Drill, alfalfa setting

**Comments:** Visited site 07/14/95. Switchgrass establishment best on buffer strips. Heavy weed competition. Visited October, 1995. Some seedhead production on sparse switchgrass density (~2-5% of seed planted) Visited site August 7, 1996. No apparent clipping had been performed since last visited in October. Uneven density of plants. Small groups and some rows evident. Plant that are apparent are vibrant and robust. Plants 2-4' high and producing seed heads. Primary competition: Quack, Timothy, Foxtail, Queens Annes Lace and Canadian Thistle.

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

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**1997 Grower Profiles continued**

**Grower:** Alan Neises, WI  
**Acres:** 2.0, tama silt loam  
**Previous Crop Use:** Corn and Alfalfa  
**Date Planted:** 06/95  
**Site Preparation:** chisel plow, disk, drill and rolled  
**Herbicide:** Round-up  
**Fertilizer:** none  
**Cultivar:** Blackwell  
**Application Rate:** 10#/acre  
**Equipment:** Seed Drill, alfalfa setting

**Comments:** Alan planted three small sites, all less than 1 acre. Visited site on 07/14/95. Very poor switchplant establishment on all three sites. Heavy infestation of quack, velvet leaf and other weeds. Visited site August 7, 1996. Sites 1 & 2 replanted in 1996 with oats cover crop. Again, less than uniform density of plants. Plants apparent 1-2' high and yet producing few seed heads. Site 3 had higher density of plants than 1 or 2. While number of plants and switchgrass clumps better established, with more seed head production, still a poorly established site, as compared to other test plots. Extensive weed competition.

**Next Action:** Discontinue as part of test plot population.

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**1997 Grower Profiles continued**

**Grower:** Dennis Fritz, Stitzer, WI  
**Acres:** 6.0  
**Previous Crop Use:** Alfalfa  
**Date Planted:** 06/95  
**Site Preparation:** ?  
**Herbicide:** ?  
**Fertilizer:** ?  
**Cultivar:** Blackwell and Trailblazer  
**Application Rate:** 8#/acre  
**Equipment:** ?

**Comments:** Did not visit site during 1995. Visited site 08/07/96. Complete ground cover with large variety of plants, both switchgrass and others. Residual alfalfa, plus brom, quack, foxtail, queen annes lace, ect. Appears to have significant switchgrass population, yet less than uniform density. Visited again October, 1996. Switchgrass producing seed heads throughout site. However, density ~ 1 plant/m<sup>2</sup>. Difficulty arranging interview with Dennis given his occupation as over-the-road trucker.

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

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**1997 Grower Profiles continued**

**Grower:** Prof & Doc Farms, LLC, Woodman, WI  
**Acres:** 9.0, three sites (A, B, & C), clay  
**Previous Crop Use:** Pasture  
**Date Planted:** 06/95  
**Site Preparation:** clipping of grasses, Autumn, 1994  
**Herbicide:** Round-up (05/25/95 all sites, pre-planting), Atrazine & Oil (sites A & C, August 20, 1995)  
**Fertilizer:** none  
**Cultivar:** Site A: Trailblazer, Site B: Blackwell, Site C: Cave-in-Rock  
**Application Rate:** 8#/acre  
**Equipment:** Great Lakes No Till Drill, alfalfa setting

**Comments:** Visited site 07/14/95. Very little switchgrass plant establishment. Significant weed competition and very dry/hot growing season. Visited site again in October, 1995. Extremely low density of switchgrass on all three sites. Visited site August 7, 1996. Partial burning of each site during April, 1996. All sites clipped and baled mid July, 1996. Partial sections of sites A & C left unclipped as control. No noticeable improvement in switchgrass density as result of management efforts. All three sites considered total crop failures. 1995 growing season characteristics (hot/dry) and less than optimal seed bed preparation assumed to be causes.

**Next Action:** Discontinue as part of test plot population.

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**1997 Grower Profiles continued**

**Grower:** Thelan Farms, Inc.  
**Acres:** 3.0, loam  
**Previous Crop Use:** Recently cleared woodland  
**Date Planted:** 06/18/95  
**Site Preparation:** Bulldozing of woodland, plowed, disked  
**Herbicide:** none  
**Fertilizer:** Cow manure, 10,000 #s of dry matter  
**Cultivar:** Cave-in-Rock, with oats cover crop  
**Application Rate:** 8#/acre  
**Equipment:** Brillion No Till Drill, alfalfa setting

**Comments:** Visited site 07/14/95. Very little switchgrass plant establishment evident, oats crop well established. No visits during 1996.

**Next Action:** Attempt to gain rental extension for at least 1997. Consider fire regimen for spring, 1997 management.

## Research Projects Status Report

February 3, 1997

### Council of Great Lakes Governor's Regional Biomass Program/Wisconsin Division of Energy: Grower Profiles

**Grower:** Prof & Doc Farms, LLC, Woodman, WI  
**Acres:** 13.0, six sites (A, B, C, D, E, & F), clay  
**Previous Crop Use:** Pasture  
**Date Planted:** 06/15/96  
**Site Preparation:** All sites burned 4/96  
**Herbicide:** Round-up (05/29/95 all sites, pre-planting), Cenex-New Horizons  
**Fertilizer:** none  
**Cultivar:** Sites B, C & D: Trailblazer, Sites A, E, F, & G: Cave-in-Rock  
**Application Rate:** 8#/acre  
**Equipment:** Great Lakes No Till Drill, alfalfa setting (Tom Gildersleve)

**Comments:** Visited site 08/07/96. Approximately 60-80% seed germination and switchgrass plant establishment. Plant growth 3-16". Best growth on sites C & D (East slope, Trailblazer) Worst growth site B, dry soil, yet still significant evidence of seed germination and initial plant growth. Slower growth and less density on western slopes, sites A, E, F & G.

Visited site again October, 1996. Switchgrass growth increased substantially since 08/96 visit. Sites C & D continue to demonstrate best germination, plant development and seed head generation rates. Uniform density of plants throughout all sites. Estimated 50-75% of plants in sites C, D and partially in A & B generating seed heads. Some plants in site C ~4-5' tall.

Lack of seed heads in sites E, F & G, yet excellent plant establishment, density and growth, 12-24" tall.

To date, these test plots have generated the most prolific and robust sites of any in our research. Key issue will be to determine whether or not these results can be reproduced. If so, we may be onto something.

**Next Action:** Mixture of burning and mowing regimens for spring of 1997.  
 Planting of an additional 17.0 acres on adjacent land during spring of 1997.

P.O. Box 528 Lancaster WI 53813 Fax (608) 723-7669 BBS (608) 348-9344

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**CGLG/WI DOE: Grower Profiles**

February 3, 1997

**Grower:** Ken Houtakker, Lancaster, WI  
**Acres:** 13.0, three sites, loam & clay  
**Previous Crop Use:** Alfalfa and corn  
**Date Planted:** early 07/96  
**Site Preparation:** Cultivator, disk & harrow, extensively worked  
**Herbicide:** Round-up  
**Fertilizer:** none  
**Cultivar:** Cave-in-Rock & Blackwell, mixed, with 2#/acre oats cover  
**Application Rate:** 8#/acre  
**Equipment:** Kraus Drill, alfalfa setting

**Comments:** Visited site 08/07/96. Little apparent seed germination and switchgrass plant establishment. Of those switchgrass plants identified, plant growth 3-9". Best growth on on top field. Visited site again 10/06/97. Top field (Cave-in-Rock) exhibited good plant density (~40-60 % of seed) and growth, 10-20". Middle field, higher clay soil, less density and plant growth than top field (~25-40% of seed). Lower field exhibited similar growth rates as middle field, but had better plant densities (~30-50% of seed). Weed competition, velvet leaf, cup plant and fox tail is significant.

Overall, an encouraging series of sites. This planting generating results which could be expected to be reproduced on a regular basis.

**Next Action:** Mixture of burning and mowing regimens for spring of 1997. Planting of an additional acres on adjacent land during spring of 1997 is possible.

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## CGLG/WI DOE: Grower Profiles

**Grower:** Richard Lange  
**Acres:** 20.0, two 10 acre sites, silt loam  
**Previous Crop Use:** Grass (brome) and landfill cover.  
**Date Planted:** 07/09/96  
**Site Preparation:** clipped and baled grass, rotar(2 passes), disked and harrow  
**Herbicide:** none  
**Fertilizer:** none  
**Cultivar:** Cave-in-Rock (south site) and Trailblazer (north site), barley cover crop (1 bu/acre)  
**Application Rate:** 8#/acre  
**Equipment:** Flex harrow, alfalfa setting

**Comments:** Visited site 08/13/96. Fair amount of plant growth but Tim Baye unable to accurately identify any switchgrass seedlings on either site. Visited site again on 10/06/96. Fields had been recently clipped. Found many small switchgrass plants, 2-6" tall throughout both sites. However, plant density appeared very inconsistent. Possible causes were extremely high competition from orchard grass and less than optimal seed bed.

**Next Action:** Consider early season Round-up spraying and follow-up burning regimen for spring, 1997 management.