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BIOMASS POWER FOR RURAL DEVELOPMENT

TECHNICAL PROGRESS REPORT
PHASE-II

Contractual Reporting Period
October-December 1999

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23 March 2000

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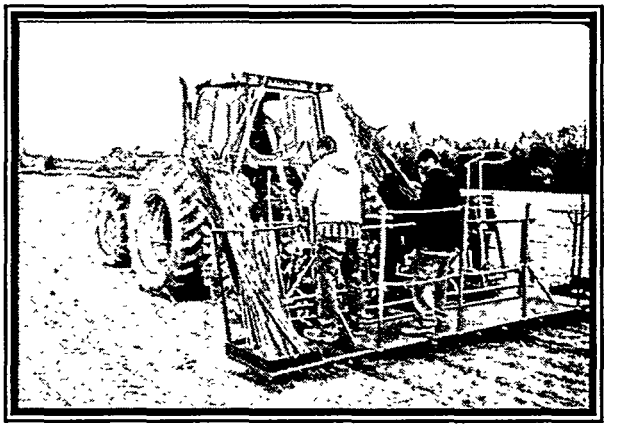
THE SALIX CONSORTIUM
PROGRESS HIGHLIGHTS
Fourth Quarter 1999

Feedstock Production and Infrastructure

- Site preparation was completed on 250 acres scheduled to be planted in 2000 in Western NY. The Consortium will have more than 500 acres in commercial scale plots planted by the Spring 2000.
- Collection of survival data was completed for demonstration areas planted in western NY in 1999. In total, over 2,770 survival plots were installed and assessed. The data is being analyzed and will provide useful information on the areas that were affected by this year's drought and other factors. Results for management recommendations will be available spring 2000.



Step Planter

- At the New York State Department of Environmental Tree Nursery at Saratoga, all materials for the production of whips and cuttings were harvested as whole stems. Processing of these materials into whips and cuttings is scheduled to begin in mid-January.
- Cutting production was initiated at the SUNY-ESF Genetics Field Station at Tully. More than 240,000 cuttings were produced at the end of December.

Power Plant Conversion and Testing

- All biomass handling and processing equipment are on site and have been installed. This includes two hammer mills, a biomass receiving hopper and bucket elevator, a magnetic separator, a storage silo and multiple conveyors. System electrical and control integration will be completed in the first quarter of 2000.

Feedstock R&D

- Measurements of rust susceptibility and insect feeding damage were completed on F1 *S. eriocephala* progeny from crosses completed in 1998. These crosses are being evaluated

for their resistance to pests and disease. F1 *S. eriocephala* is the most promising Native material because it is variable in form. Measurements of form, stem diameter, and tree height will be completed before trees are harvested for cuttings during winter 1999-2000. The results of these tests will assist in planning future commercial scale willow plantings.

- Bird counts made in fifteen SRIC-plots located at six sites in NY State from April through September 1999. A total of 31 bird species were counted. Sixty-eight nests of nine different species were found. A preliminary analysis of the 1999 breeding season showed that the willow plantations nest density, and hence presumably breeding density, increases with the age of the willows. More data will be needed to determine how much plot size effects bird density.

Enterprise Development

- Natural Resources Conservation Service State Conservationist, Rick Swenson, toured the clonal trials at Tully, NY. Discussions were held on use of willow biomass crops on Conservation Reserve Program land. The goal is to gain acceptance of the willow system as a productive soil conservation crop.
- SoCNY RC&D has been in contact with a western NY pellet fuel manufacturer about the possibility of using willow as feedstock. Discussions were also held on potential business opportunities for the fuel.
- SoCNY RC&D organized the Second Community meeting in Jamestown, NY on October 6th. Michael Boismenu, Dunkirk Steam Station Manager, provided an overview and update on co-firing retrofits and future plants at the power plant. Mike Boismenu also presented the benefits of the cofiring project to senior NRG management.

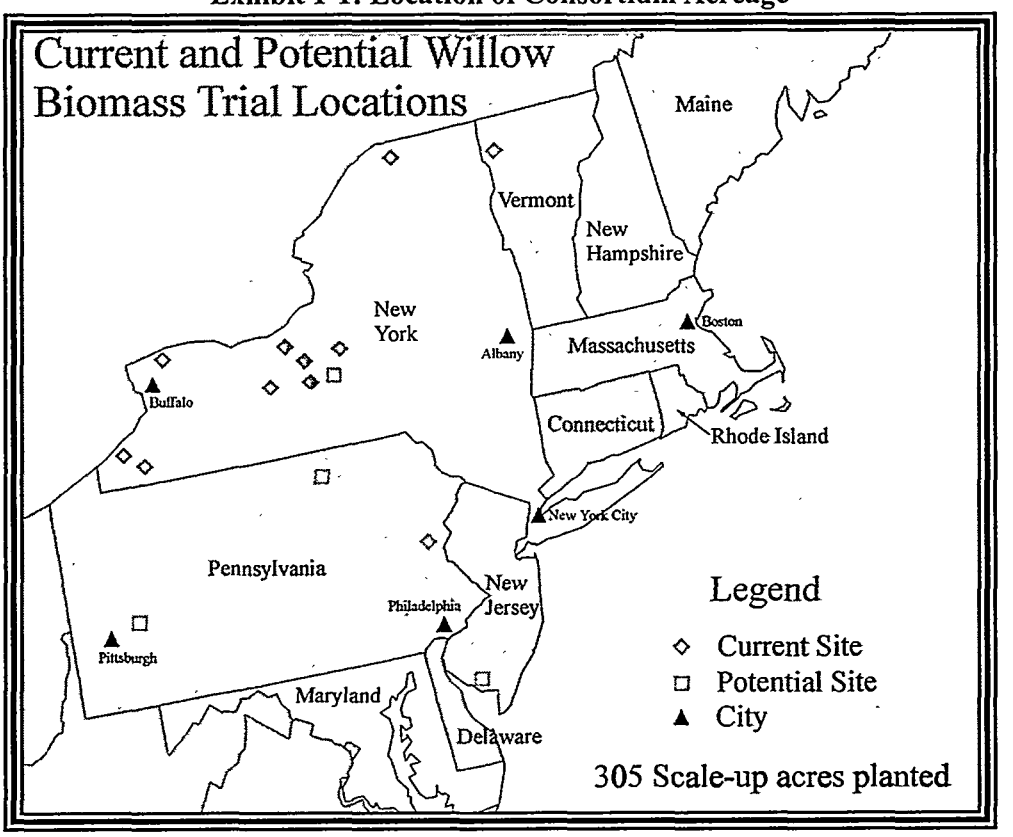
1.0 INTRODUCTION

The project undertaken by the Salix Consortium is a multi-phased, multi-partner endeavor. Phase I focused on initial development and testing of the technology and forging the necessary agreements to demonstrate commercial willow production. The Phase I objectives have been successfully completed:

- preparing design plans for two utility pulverized coal boilers for 20 MW of biopower capacity;
- developing fuel supply plans for the project with a goal of establishing 365 ha (900 ac) of willow;
- obtaining power production commitments from the power companies for Phase II; obtaining construction and environmental permits; and
- developing an experimental strategy for crop production and power generation improvements needed to assure commercial success.

The R&D effort also addresses environmental issues pertaining to introduction of the willow energy system. Exhibit 1-1 shows the locations of willow biomass trials and scale-up acreage in the Northeastern United States. Not shown are Consortium activities in Rhinelander, Wisconsin.

Exhibit 1-1: Location of Consortium Acreage

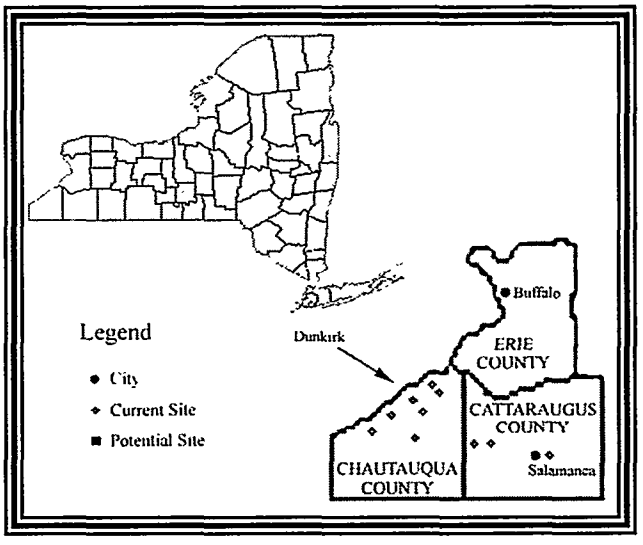


In Phase II, every aspect of willow production and power generation from willow biomass will be demonstrated. The ultimate objective of Phase II is to transition the work performed under the Biomass Power for Rural Development project into a thriving, self-supported energy crop enterprise.

1.1 Project Overview

The Salix Consortium pools the research and investment interests of over 20 corporations, associations, universities and regional government agencies in a well orchestrated program to develop a new energy crop enterprise. More than 37 farmers and landowners representing over 3,000 acres of potential willow production have met with Consortium representatives and expressed interest in the new energy crop. Although some of these landowners/growers are too far away to be considered in this demonstration, 22 landowners representing 770 ha (1,900 ac) of land have been screened for participation in the project (Appendix A). From this pool of acreage combined with utility-owned land and other Consortium experimental plots, 365 ha (900 ac) of willow for energy production will be available in Phase II. The Consortium continues to add to the prospect list of participating landowners through outreach activities.

Exhibit 1-2: Dunkirk Sites



Consortium regional representation is focused in the Northeast, stretching from Ontario to Delaware and expanding into the Midwest. Cofiring tests have been conducted at both Niagara Mohawk Power Corporation's (NMPC) Dunkirk, New York State Electric and Gas' (NYSEG) Greenidge, and GPU's Seward and Shawville power stations. The basic fuel handling system at Greenidge has demonstrated continuous firing at 10% by heat input. An initial test firing of the willow at Greenidge station has already been performed and has provided insight into the issues to be addressed in Phase II to assure efficient use of the willow energy crop. NMPC recently completed successful tests cofiring biomass in one corner of a boiler at its Dunkirk Station. NMPC is now retrofitting this boiler for full-time cofiring. The focus of the Salix Consortium is on energy crop infrastructure and development first and conversion technology second in the belief that the major tasks ahead are to develop an economical crop production infrastructure for the business. Nonetheless, energy conversion issues are effectively addressed in the program and advanced technologies through gasification are included with a realistic timetable for implementation. All of the preceding efforts contribute to the project team's belief that this Consortium will be the *first in the nation to develop an economically and environmentally sustainable business in energy crops for power generation* and ultimately a variety of high value energy products.

1.2 Description of Tasks and Goals

The Consortium has organized its activities into four distinct tasks. A brief description of the objectives of each task in this section of the report.

Task 1 - Feedstock Production and Infrastructure
Task 2 - Power Plant Conversion and Testing
Task 3 - System Optimization and Experimental Studies
Task 4 - Enterprise Development

1.2.1 Task 1 - Feedstock Production and Infrastructure

TASK 1
★ *ACREAGE SCALE-UP*
★ *NURSERY PRODUCTION*

Task 1 activities focus on acreage scale-up and willow field production activities. During Phase II, the Consortium will establish 365 ha (900 ac) of willow in New York. To accomplish this, the Consortium will ensure that sufficient planting stock is produced, production sites are prepared, and that planting, monitoring, maintenance, and harvesting activities are developed in a manner consistent with establishing an energy crop enterprise. All planning, land acquisition, and commercial field activity associated with this project are managed under Task 1.

1.2.2 Task 2 - Power Plant Conversion and Testing

TASK 2
★ *PLANT RETROFITS*
★ *EMISSION MONITORING*

Task 2 activities focus on resolving issues related to the power plants and conversion of a delivered willow product into electricity. The goals for Task 2 efforts in Phase II include the retrofitting and continuous cofiring of biomass at Dunkirk Station, continued operation and testing of Greenidge Station, and gasification tests using willow at McNeil Station. The Consortium will also collect operational data such as manpower requirements and maintenance costs. However, emissions monitoring and ash testing activities will be managed under Task 3.

1.2.3 Task 3 - System Optimization and Experimental Studies

TASK 3
★ *CROP R&D*
★ *ENVIRONMENTAL STUDIES*
★ *OPERATION IMPROVEMENTS*

All research and development activities are managed under Task 3. This includes willow feedstock and production system R&D, environmental and sustainability studies, and power generation optimization efforts. Specifically, the Consortium will seek to improve willow yields and pest resistance while maintaining site productivity. The Consortium will evaluate willow site preparation techniques, planting and harvesting equipment and quantify the environmental characteristics of willow biomass crops.

1.2.4 Task 4 - Enterprise Development

TASK 4
★ *BUSINESS DEVELOPMENT*
★ *OUTREACH*

Task 4 will focus on Business Development and Optimization activities that will lay the foundation for the long-term viability of a willow production enterprise. The Consortium will investigate ways to capitalize on existing federal, state, and local government programs to increase the competitiveness of the crop. Forest management and agricultural tax structures, Conservation Reserve Programs, and eco-enterprise zones are examples of avenues being pursued. These activities plus on-going outreach and technology transfer are aimed at ensuring the successful transition of this project from demonstration to commercialization.

1.3 Work Schedule and Deliverables

A complete work schedule and list of corresponding deliverables for each partner is provided in Appendix B. A summary of that schedule is provided below.

2.0 DETAILED TASK PROGRESS REPORTS

2.1 Task 1 - Feedstock Production and Infrastructure (WBS 1.0)

2.1.1 Nursery Operations

Nursery operation for demonstration (WBS 1.1)
Nursery Production Improvement (WBS 3.1.2.)

At the New York State Department of Environmental Tree Nursery at Saratoga, all materials for the production of whips and cuttings were harvested as whole stems. All the material is being stored in the freezer facility. Processing of these materials into whips and cuttings is scheduled to begin in mid-January.

Cutting production was initiated at the SUNY-ESF Genetics Field Station at Tully. A seasonal field crew was hired to assist with these operations. By the end of December, over 240,000 cuttings were produced in the form of 1.3 m to 1.7 m long whips and 20 cm long individual cuttings. These cuttings will provide sufficient material to plant approximately 40 acres in the Spring.

2.1.2 Acreage Scale-up Activity Dunkirk/Greenidge

Willow Production and Scale-up for Dunkirk and Greenidge (WBS 1.2)

<u>2000 Planting (250 Acres)</u>

Site preparation continued on sites in central and western NY for areas scheduled to be planted in 2000. In western NY, site preparations by FORECON included plowing, discing, rock removal, strip-planting of a cover crop, and cultipacking. Site preparations were complete on 250 acres, by the end of October.

<u>1999 Planting (205 Acres)</u>

Coppicing operations were initiated by FORECON in demonstration plantings in western NY in 1999. Initial attempts to coppice the Gerry site in early December were halted because the soil was too wet to support the tractor. Colder weather later in the month allowed access to the field.

Collection of survival data was completed for demonstration areas planted in western NY in 1999. Sampling followed the Standard Operating Procedure developed by SUNY-ESF. A statistically random sample was collected for each field section that was planted. In total over 2,770 survival plots were installed and assessed. The data is being analyzed and will provide useful information on the areas that were affected by this year's drought and other factors. These figures and the visual assessments of growth that were collected, will be used to develop management recommendations for fall 1999 and spring 2000 field activities.

<u>1998 Planting (115 Acres)</u>
No additional activity to report at this time

Cutback Study

Study Objective
The objective of this study is to determine how cutback operations effect the production of willow bioenergy crops.

Current Progress
This study is replicated at three sites in central NY (Wolcott, Tully, and Canastota) and was established in 1998. Cutback treatments were conducted during winter 1998/99. Height measurements were completed during October at all three sites. This is the fourth in a series of ongoing height measurements. Leaf area measurements were taken in all 54 plots at Tully using a Li-Cor 2000 plant canopy analyzer. One final set of height, stem diameter, and leaf area measurements were collected during fall 1999.

2.1.3 Acreage Scale-up Activity Other Sites

Willow Production at Other Sites (WBS 1.3)

Burlington Electric

Re-measurement of tree survival occurred in late December. This provided better access and visibility since it was long after leaf fall. Most clones showed high rates of survival (89%-99%) in this, the second year after coppice. One replication of SV1 and one of S365 showed drastic reductions in survival (66.2% and 50.9%). It is hypothesized that the decline is related to a combination of to an exceptionally high water table during the summer of 1998 and insect activity. Although mortality in willow (due to high water) was never anticipated, a deterioration of the root systems below the upper three inches was observed.

2.2 Task 2 - Power Plant Conversion and Testing (WBS 2.0)

2.2.1 Dunkirk Station

NMPC Dunkirk Station (WBS 2.2)
Procurement, Installation and (WBS 2.2.1)
Performance, Operation and Environmental Evaluation (WBS 2.2.2)

Retrofit of the Dunkirk Station was materially completed during this reporting period. All equipment is on site and the majority has been installed including hammer mills, a receiving hopper, a silo, and pneumatic transport equipment. The last major component to be installed is the bucket elevator which will be used to move material from the receiving pit to the primary fuel hopper. NMPC and NRG staff expect to complete installation at the station late in the 1st quarter of 2000.

2.2.2 Greenidge Station

NYSEG - Greenidge Station (WBS 2.1)
Final Modifications & Testing (WBS 2.1.1)
Performance, Operation and Environmental Evaluation (WBS 2.1.2)

Greenidge continues to cofire biomass at the 10% level. AES is monitoring the success of the willow demonstration at this stage.

2.2.3 *Vienna Station*

Biomass Conversion Facilites (WBS 2.3)
Retrofit Options (WBS 2.3.1)
Biomass Fuel Handling and Integration (WBS 2.3.2)

Vienna was sold during this period to NRG. The feasibility study was completed. Until the sale is completed and the plant goes into operation for NRG the biomass retrofit will be on hold.

2.2.4 *McNeil Station*

BED McNeil Station (WBS 2.4)

Work continues on testing and modifications to the gasifier. Willow may not be fired until the fall of 2000.

2.2.5 *Ontario Hydro*

Ontario Hydro Cofiring and Distributed Generation (WBS 2.5)

No new progress to report at this time.

2.3 Task 3 - System Optimization and Experimental Studies (WBS 3.0)

2.3.1 *Willow Feedstock R&D*

Willow Feedstock R&D (WBS 3.1)
Genetic Improvement (WBS 3.1.1.)
Crop Improvement (WBS 3.1.3.)

Genetic Improvement

Study Objective

The objective of this effort is to develop highly productive willow clones that are adapted to New York State as quickly as possible. This includes production of intra- and interspecific hybrids between species that have shown promise in previous studies and identifying molecular markers that identify inheritance patterns for desirable traits.

Current Progress

A research proposal entitled "Willow Crop Development Center for the Northeast and North-Central United States" was submitted to U.S. Department of Energy Oak Ridge National Laboratory (ORNL). If funded, willow genetic improvement efforts will be continued and significantly increased to develop clones specifically for the Northeast and North-Central states. Dr. J.G. Isebrands, USDA Forest Service at Rhinelander, Wisconson will lead the work in the North-Central region. Additional wild clones will be collected from across the Northeast and North-Central region. Project duration is five years.

Measurements including height, stem diameter, insect feeding damage, rust susceptibility and gender were completed in the willow cutting orchard that was planted during spring 1999. The site contains clones produced by controlled pollination during 1998 (F1-98 progeny). The trees were harvested during December and at least 34 cuttings were obtained from most of the *S. eriocephala* progeny. Replicated clonal progeny tests will be planted on two sites during spring 2000 if funding is available. These trials will provide information that will increase the efficiency of future willow breeding efforts. Cuttings were made from hybrid clones planted in

the same cutting orchard. These cuttings will be planted in a new cutting orchard during spring 2000 to scale up these promising clones for field testing as quickly as possible.

Shoot tips bearing flower buds were collected from the F1-98 progeny to use for breeding. Crosses will be attempted that will yield F2 progeny suitable for genetic mapping studies.

Efforts continued to develop molecular fingerprints of the *S. eriocephala* F1 progeny that were produced during 1998, and their parents, using amplified fragment length polymorphism (AFLP). Reproducibility problems experienced during summer 1999 were not resolved. Isolating the problem is difficult because of the complicated protocol and lack of suitable experimental controls. A researcher at SUNY-ESF began using AFLP fingerprinting on a separate project, so information exchange will accelerate protocol optimization for both parties. Sounds like a problem that should be carefully reviewed before plowing more dollars into the project.

In central NY, site preparation by SUNY-ESF included stump removal from an old poplar plantation, plowing, discing, and planting of a cover crop of winter rye at the SUNY-ESF Genetics Field Station. Winter rye was also planted at Lafayette. This is not genetic work.

Genetic Selection Trail and Ecophysical Basis for Relative Productivity

Study Objective
The purpose of this effort is to further develop the willow clonal stock available for planting. This effort is also targeted at increasing crop productivity and sustainability through natural selection, biological characterizations, and tree breeding.

Current Progress
Soil moisture, plant area index, and light interception measurements continued as scheduled. Plant area index and light interception continued until shortly after leaf fall. A leaf senescence survey was initiated in October and continued through November. Soil samples were collected for measuring bulk densities. The weather station was disconnected and will be reconnected in early spring 2000. Collection of end of season height and diameter measurements is ongoing.

Montreal Study

Study Objective
The purpose of this effort is to test the viability of genetic material supplied by SUNY ESF in a more northern climate with different soil and growing conditions. In exchange, Montreal will provide genetic material for inclusion in SUNY ESF's breeding program and trials.

Current Progress

The growth and the development of willow planted in 1995 and 1996 and coppiced in fall 1998 were monitored. Six plants per species were (S. discolor and S. viminalis) randomly chosen at the beginning of the season. After leaves dropped in November 1999, the diameter at the base, the height of the main stem, and the number of the stems were measured. The same plants were coppiced and weighed in the field in order to estimate the green biomass yields. The productivity per ha was then evaluated.

The first results show that the growth and productivity of species were positively affected by the clay texture of the plantation site. However, the production in biomass was negatively affected (on all the plantation sites) by the weak precipitation recorded during the summer. After two years of growth, the biomass production of willow planted in 1995 (five years old roots) was higher than the willow planted in 1996 (four years old roots).

During November 1999, two hectares of willow (one ha on the clay site and one on the sandy soil) planted in 1996 were coppiced in order to experiment with different coppice cycles on the productivity in biomass. The green biomass was transported out of the field and will be chipped at the end of next summer.

At the beginning of December 1999, the growth and the biomass productivity recorded by 12 other willow clones that were planted in the spring were analyzed. The methodology used was developed in collaboration with researchers of SUNY-ESF. The results, which were forwarded to SUNY-ESF, will be the subject of a comparative study with those recorded by the same clones planted under different soil and climatic conditions in northern Pennsylvania and in Delaware.

At the end of November, samples of stems and branches were harvested to evaluate the concentration and the content in nutrients in biomass. The samples were dried and their contents in principal elements analyzed by colorimetry and spectrophotometry by atomic absorption. A total number of 192 samples are being analyzed at the laboratory.

A number of samples of the lixiviats were collected, using lysimeters, to measure the heavy metal concentration in the soil solution following the wastewater sludge fertilization. The first results showed very small quantities of nitrates and metals leached into the groundwater (below permissible limits).

At the end of November, 2000 cuttings of S. viminalis were prepared for our collaborators of SUNY. 2000 branches of S. viminalis (2 - 4 m length) were also harvested and used for the bank stabilization within the framework of a project initiated by the town of Iberville (south of Montreal).

During September 1999, a visit was organized on the plantations of willows with the participation of representatives of Ministry for the Natural Resources of Canada, of Ministry of Forestry of Quebec and the Laurentides Center of Forestry. Discussions showed the will of promoters to continue encouraging the activity of research and development on the intensive cultures of the trees by short rotations.

Crop Improvement

Crop improvement includes the efforts on the R&D activities listed below. Details are provided for efforts with substantial new progress during this reporting period.

- Establishment of a Clonal Selection Trial and Studying the Ecophysiological Basis for the Relative Productivity
- Clone-Site Testing and Selections for Scale-up Plantings
- Alternative Methods of Site Preparation (USDA CSREES)
- Application of Poultry Manure on Willow Biomass Crops (NYSERDA/Wegmans Egg Farm Inc.)
- Use of Biosolids as Organic Soil Amendment in Willow Bioenergy Plantations (NYSERDA)
- Effect of Slow-Release Nitrogen Fertilization on Aboveground Biomass Production of Five Salix Clones and One Populus Clone in a Short-Rotation-Intensive-Culture (SRIC) Bioenergy Plantation
- Integrated Pest Management in Willow Biomass Crops (EPRI for 1997-1998)
- Aboveground Biomass Equation Development for Five Salix Clones and One Populus Clone
- Effect of Storage Conditions on the Survival and Growth of Willow Cuttings

Managing Cover Crops in Willow Bioenergy Systems

Survival and height measurements were collected in this two-acre trial. The late planting date and drought resulted in low survival rates. A decision was made to plow the trial under and repeat the planting in 2000. The site was reworked and planted with a winter rye cover crop in anticipation of replanting the trial in the spring of 2000.

2.3.2 Willow Production Systems

Production Systems (WBS 3.2)
Planting System Testing (WBS 3.2.1)
Planting System Optimization (WBS 3.2.2)
Harvesting/Field Processing System(WBS 3.2.3)
Evaluation of Other Supply Dynamics (WBS 3.2.4)

Production Equipment Performance Monitoring and Measurement

A data acquisition system has been designed and partially developed to give information about the planting and harvesting activities of Salix. Inputs such as position, fuel usage, and crop production have been incorporated into the system. A global positioning system (GPS) is used to locate the planter or harvester. Position is used as a reference to the activities occurring in the field. The measurement of fuel usage is based on the engine RPM. Engine RPM is measured using a tachometer, which will be calibrated for fuel usage.

Willow yield is a key variable in the economical models for willow production. The crop yield is based typically on dried weight. The field measurement is of wet or green weight. A sampling protocol will transform the green weight to dry weight. The wet weight measurement is accomplished with a weigh wagon that is equipped with load cells to measure the mass in the

wagon and its contents. The weight recorded together with other economical inputs, such as time, fuel use, and position, can be used in the economical models.

The data acquisition system is portable and can be setup quickly. Measurements can be recorded for up to 3 hours. Extended periods can be gained with modifications and different equipment. The weigh wagon is detached with the removal of the draw pin and the cable connection. The tachometer is quickly changed by the removal a few bolts. Transporting the system is effortless. Overall, the system is a compact package that is able to collect accurate data.

Preliminary field data in the spring of 1999 provided a base to compare planting rates, down time, and loading time for two different planters. Information collected during harvesting will allow a similar characteristic to be determined as well as yield and fuel usage.

Planter Modifications

Installation of Step Planter feed drive modification

The newly designed modifications to the revolver feed drive were installed September 10, 1999. The required parts and installation was furnished and completed by the manufacturer. See figure 1 through 2 for parts installed. The modification of the revolver and stem feed arm resulted in a reduced cuttings length from 10 inches to 7.5 inches. This is a result of the increased travel for the new revolver pivot arm. The cutting lengths used last spring were 8-inch cuttings. An increase cutting length would require a redesign of the revolver belt feed drive.

Step Planter Improvements

A number of improvements were recommended after last springs planting.

- Quick spring release for the friction drive to aid in clearing machine jams.
- Marker hydraulic control to improve sensitivity and field worker safety.
- Modify planter limit wheels to aid the loading of the planter on a transport truck or trailer.

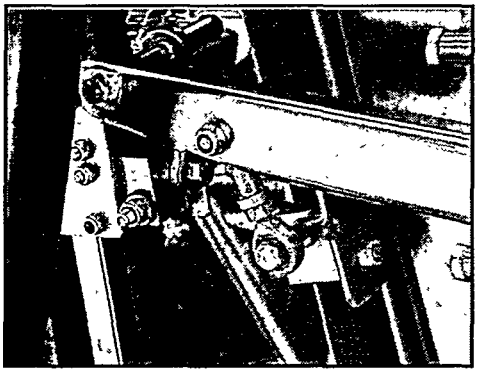


Figure 1. Initial feed drive

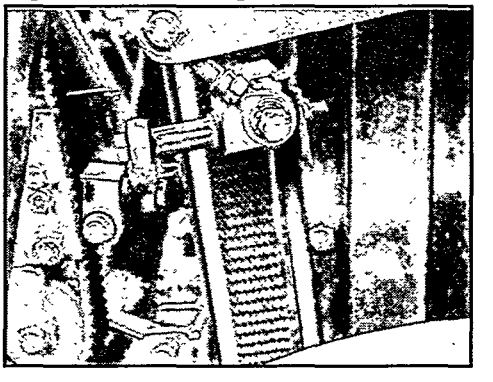


Figure 2. Modified drive arm

Improvements are under review by the manufacturer and will be incorporated in the spring 2000 planting.

Harvester Selection

Cornell University ABEN conducted an evaluation of harvesting equipment and delivery systems for short rotation willow crops. Three harvesters, the Austoft 7700, Claas Jaguar 695 and Bender II, were compared for performance and cost. The comparisons were based on European research data and personal field observations. The harvester must be able to harvest 160 ha/year, with plantings located within a 80 km (50 mile) radius of a co-firing electric power plant and in fields whose sizes range from 4 to 40 ha (10 to 100 acres). Cuttings are planted at spacing similar to that used in Sweden. The trees are willow clones with expected growth rates of 11-16 dry tons per hectare per year (5-7 dry ton per acre per year). All three of the harvesters evaluated could meet our requirements. However, the harvester selected will be based on cost, ease of transportation and multiple uses.

The Bender harvester patented and built by Salix Maskiner AB from Sweden was recommended over the Austoft and Claas machines. Based on the data collected by the Cornell team on visits to the harvesting tests in Europe and manufacturers and on the results of European studies, a comparison of the harvester's performance and operating cost was reviewed and is described in the ASAE paper 995055. The final conclusions were:

1. The harvesting machine selected must be able to harvest 120 to 162 hectares (300 to 400 acres) per season. All machines meet this criterion. Therefore, completion of harvesting on the demonstration acreage can be accomplished by all of the machines assuming a 120 day harvest season for northeastern US.

2. The harvesting machine selected must have a reasonable cost of operation. All machines have similar costs for producing one oven dry ton (odt).

3. The Bender has a significantly lower initial cost even with the purchase of a tractor to power the Bender. The tractor can be used for other field operations (planting, coppicing, weed control, fertilizing). The tractor could be fitted with tracks for better control in the field.

4. Quality of cut and chip appears to be similar for all machines.

5. Stool damage appears to not be a problem with proper choice of cutting blades for all machines.

GPS Upgrade

The current configuration of the GPS system provides limited resolution as demonstrated during last years planting. Cornell University investigated an improvement to the GPS system with a dual GPS system that makes use of a reference station as well as the orbiting satellites. There are reference stations near the western New York planting areas used for navigation on Lake Erie and other reference station in upstate New York for use with the Tully and other upstate New York planting areas. The upgrade has been identified but must be implemented and changes made to the data acquisition system (Campbell Unit). Accuracy using this new technology could be improved by as much as 86-93%.

Tractor Specification

The tractor specifications are being collected in order to have a single machine that can be used with both the step planter and harvester. Furthermore, we are attempting to solve the problem of loading and unloading both the step planter and the harvester from the trailer. As these machines are almost one of a kind, it has been important to coordinate closely with the Swedish Manufacturer of the harvester and step planter, the US tractor manufacturers, and final users FORCON and ESF.

2.3.3 Environmental Studies

Environmental Studies (WBS 3.3)

Root Study

Study Objective

Roots account for a significant portion of the carbon budget in trees. The intent of this study is to answer scientific questions key to understanding the long term carbon sequestration ability of willow crops.

Current Progress

A fifth set of video-camera readings were taken in the minirhizotrons inserted in plots at the SUNY-ESF Genetics Field Station at Tully. Repeated measurements in these plots will form the basis of an assessment of root production and turnover over the coarse of a growing season. Plant area index and height measurements were taken in conjunction with the root measurements.

Avian Studies

Study Objective

The objective of this effort is three fold: 1) Determine the impact of clonal structure differences on avian habitat sustainability; 2) Determine the impact of plot size on community composition and richness; and 3) Determine the influence of plot size on nest parasitism by cowbirds, or other nest predators.

Current Progress

Birds were counted in fifteen SRIC-plots located in six sites in NY State from April through September 1999. These plots were planted with willow clones one to three growing seasons old. Different clones or groups of clones were planted in each plot. A total of 31 bird species were censused. Sixty-eight nests of nine different species were found. The results for the 1999-breeding season produced results roughly similar to these obtained in similar habitat in 1998 and 1997, although more breeding species have been found. This preliminary analysis of the 1999 breeding season shows that in the willow plantations nest density, and hence presumably breeding density, increases with the age of the willows. More data will be needed to determine to what extent plot size has an effect on bird density.

Nesting Results

Details about the numbers of nests per plot are given in Table 5. All nests found in 1999 season were in 2- or 3-year old willows. Nests of nine species, including American Goldfinch, American Robin, Cedar Waxwing, Gray Catbird, Killdeer, Red-winged Blackbird, Song Sparrow, Willow Flycatcher, and Yellow Warbler were found. Although the sample size is small, the data suggest that the density of nests is higher in 3rd-growing season plots (4.4 nests per acre) than in 2nd season plot (3.8 nests per acre).

Exhibit 2-2. Number of nest by plot

Plot	Lafayette rd	Barn Site	Weather Station	Area 4	Total
Willow growth season	2nd	3rd	3rd	3rd	
Plot size (ac)	7.0	5.5	3.7	0.1*	
Bird Species					
American Goldfinch	17	3	2	2	24
American Robin	1	13	5		19
Cedar Waxwing	6			1	7
Gray Catbird	1	5	1	1	8
Killdeer	1				1
Red winged Blackbird			3		3
Song Sparrow	1				1
Willow Flycatcher				1	1
Yellow Warbler		1	2	1	4
Total	27	22	13	6	68
Nests/ac	3.8	4.0	3.5		

First Willow Growth Season Habitat
In 1999, no breeding species were found in the willows in their first growing season. This contrast with results from 1998 season, in which American Goldfinch was a breeder. Among visitors, we recorded 15 species.

Second Growth Season Habitat
This year Lafayette Rd was the only plot in the 2nd growing season. In this plot, six breeding species were found four of which (American Goldfinch, American Robin, Cedar Waxing and Gray Catbird) already recorded in a 2nd year plot last year. In additional 13 visitors species were recorded. Nests of two early breeders, Killdeer and a Song Sparrow, were found on the ground. This year Brown headed Cowbird were found as visitors.

Third Growth Season Habitat
There were 3 plots in 3rd growth season (Table1). Although the 1998 and 1999 plots in this category were not the same, the breeders species recorded were the same in both years. A total of ten species were found as Visitors.

2.3.4 Power Generation Optimization

Power Generation Optimization (WBS 3.4)
Power Production Performance (WBS 3.4.1)
Environmental Studies (WBS 3.4.2)
Combustion By-Products Research (WBS 3.4.3)
Willow Fuel Integration at Vienna (WBS 3.4.4)

During this period, Niagara Mohawk conducted a study of biomass reburn technologies for Dunkirk Station. The study suggested that biomass reburn may provide significant economic and environmental benefits over biomass cofiring. The staff at Dunkirk Station are reviewing the opportunity to retrofit the station with such a technology sometime in the future.

2.4 Task 4 - Enterprise Development (WBS 4.0)

2.4.1 Business Optimization and Analysis

Business Optimization and Analysis (WBS 4.1)
State Programs and Policy WBS 4.1.1)
Use of CRP Lands (WBS 4.1.2)
Market research for Willow Production (WBS 4.1.3)
Business Analysis (WBS 4.1.4)

SUNY-ESF staff visited the Pennsylvania Power & Light (PP&L) Montour Preserve in Montour, PA, with Stratton Schaeffer. Opportunities for establishing a third willow biomass clone site trial in Pennsylvania, in conjunction with PP&L, were discussed. Frederick Gast of PP&L identified several sites at the preserve that were inspected and ranked for suitability for growing willow. All sites were in annual crops last year so it should be possible to successfully complete site preparation prior to planting in the spring of 2000.

ANTARES and SUNY ESF staff are working towards completing an economic model for a future willow enterprise by June of 2000. The model will be used to answer key questions regarding appropriate incentives and business structures for such an entity.

South Central RC&D and SUNY-ESF staff met with the Natural Resources Conservation Service State Conservationist Rick Swenson at the SUNY-ESF Genetics Research Station at Tully, NY. Research and demonstration plots were toured. Discussions were held on use of willow biomass crops on Conservation Reserve Program land. The Salix Consortium is pursuing becoming one of six projects nationwide to be listed under a new CRP harvesting exemption for bioenergy crops. Discussions were held on the use of willow biomass crops in riparian zones. A main barrier to the acceptance of this concept by farmers is the limitation on harvesting material from these buffers. All parties expressed interest in pursuing changes to the current harvesting restrictions.

SoCNY RC&D contacted D. Wilson, Chautauqua County SWCD and F. Finnerty, Chautauqua FSA to discuss CRP and request information on acreage, sign up schedules and percentage of Non-Highly Erodible Land.

SoCNY RC&D has been in contact with a western NY pellet fuel manufacturer about the possibility of using willow and discussed a future tour of his plant. SoCNY RC&D sent a copy of Resource Efficient Agricultural Production which is Canada's report on pelleting results for willow, switchgrass and pine needles.

SoCNY RC&D created economic data collection sheet for Growers to use to collect willow fall site preparation costs information.

2.4.2 Enterprise Development

Enterprise Development (WBS. 4.2)
Converting Demonstration to Enterprise (WBS 4.2.1)
Outreach (WBS 4.2.2)

SoCNY RC&D organized the Second Willow Biomass Community meeting in Jamestown, NY on October 6th. Fifteen people attended the second willow biomass community meeting held at the Frank Bratt Agricultural Center. SUNY-ESF personnel provided a slide presentation on the willow biomass program and addressed questions.

Requests for willow for basketry, furniture, and other craft uses continue to be reviewed. SUNY-ESF provided 100 whips of Salix purpurea clones that were woven into living fences and other structures. A willow festival was held at Long House Reserve on Long Island.

SUNY-ESF personnel attended the Soil Science Society of America Annual Meeting (October 31-November 4, 1999 at Salt Lake City, UT). A paper entitled "Microbial Biomass Carbon in Short-Rotation Intensive Culture (SRIC) Systems" was presented. Three posters entitled "Carbon Enrichment in Soil Physical Fractions in Short-Rotation intensive Culture (SRIC) Systems", "Effect of Temperature of Mineralization of Nitrogen from Sewage Sludge and Poultry Manure Compost", and "Fertilization of Short-Rotation Woody Crop Plantation with Slow-Release Nitrogen" were also presented.

SoCNY RC&D arranged for space in the NYSEG area at the NY Farm Show, Feb 24-26. The new Step Planter will be displayed alongside the Willow BioEnergy Project informational display.

Presentations and Papers

The following paper and posters were presented at the Soil Science Society of America Annual Meeting. Copies of the abstracts are attached (Appendix C).

F. Ulzen-Appiah, R.D. Briggs, L. Abrahamson and D. Bickelhaupt. Carbon Enrichment in Soil Physical Fractions in Short-Rotation Intensive Culture (SRIC) Systems. State University of New York, College of Environmental Science and Forestry.

Ulzen-Appiah, R.D. Briggs, L. Abrahamson and D. Bickelhaupt. Microbial Biomass Carbon in Short-Rotation Intensive Culture (SRIC) Systems. State University of New York, College of Environmental Science and Forestry.

H.G. Adegbidi and R.D. Briggs. Effect of Temperature of Mineralization of Nitrogen from Sewage Sludge and Poultry Manure Compost. State University of New York, College of Environmental Science and Forestry.

B.D. Ballard and R.D. Briggs. Fertilization of Shourt-Rotation Woody Crop Plantation with Slow-Release Nitrogen. State University of New York, College of Environmental Science and Forestry.

SoCNY RC&D spoke about the Willow Biomass Project at SWCD meetings in Schoharie, Cayuga, Chenango, Thompkins and Otsego counties.

A presentation about the willow biomass project and a field tour of willow biomass crops planted in western New York was provided by SUNY-ESF to the Northeast Regional Biomass Program Steering Committee on October 27.

SUNY-ESF presented updates on the progress of scale-up efforts in western NY and preliminary results from ongoing research at the semi-annual US Department of Energy meeting, held at Dunkirk, NY on December 2-3. A copy of the information presented is attached (Appendix C). The meeting included tours of the Dunkirk Steam Station and willow plantings in Leon and Sheridan.

A presentation about the environmental benefits associated with willow biomass crops was made to the Mid-Atlantic Green-e Biomass advisory board in Philadelphia on December 7. The goal of the workshop was to educate members of the advisory board about the different types of biomass and generation technologies available in the region. The potential environmental benefits associated with different forms of biomass and their impacts on the renewable energy market were discussed. This advisory group will make recommendations on the types of biomass that should be included in the Green-e standard for the Mid-Atlantic region.

SoCNY RC&D arranged a presentation at Chautauqua Conservation Field Days, May 31-June 1, 2000. SoCNY RC&D has been working with participating landowners and Antares to have Ralph Overend, NREL, lecture at Summer Series at Chautauqua Institute in 2000. Week three of

the program is titled "Engines of Change: Science and Technology" and will address how advances in biotechnology, renewable energy and information technology will drive changes in the future.

APPENDIX A
List of Potential Acreage Scale-up Sites

SUMMARY OF DUNKIRK AREA ACREAGE

NAME	COUNTY	SITE VISIT	TOTAL ACRES	PLANTED ACRES	COMMENTS
HOPKINS, ANGELA	CHAUTAUQUA	YES	47	34	PLANTED APPROX 34 ACRES (1998). PAID THROUGH MARCH 31, 1999
SMITH, CHUCK	CHAUTAUQUA	YES	20	16	PLANTED APPROX 16 ACRES (1998). PAID THROUGH MARCH 31, 1999
KLOSINSKI, DAN	CATTARAGUS	YES	37	20	PLANTED APPROX 20 ACRES (1998). PAID THROUGH MARCH 31, 1999
GREEN, KATHLEEN	CHAUTAUQUA	YES	50	25	PLANTED APPROX 25 ACRES (1998). PLANTING FAILED. WILL REPLANT IN 1999. PAID THROUGH MARCH 31, 1999
CONTI, SAM	CHAUTAUQUA	YES	55	16	CONTRACT SIGNED FOR 16 ACRES (1999 PLANTING)
BROWN, ALBERT	CHAUTAUQUA	YES	42	20	CONTRACT SIGNED FOR 20 ACRES (1999 PLANTING)
DUCK, RICKY & STACY	CATTARAGUS	YES	160	100	CONTRACT SIGNED FOR 100 ACRES (1999 PLANTING)
GERNATT, DAN	CATTARAGUS	YES	100	66	CONTRACT SIGNED FOR 66 ACRES (1999 PLANTING)
Available / Planted			***511***	***297***	
LESCH	CHAUTAUQUA	YES	120		LAND IN ESTATE. NOT LIKELY TO HAVE LAND SECURED FOR 1999
MALVESTUTO, BOB	CHAUTAUQUA	YES	400		RENTED FOR 1999. NEGOTIATING FOR 2000.
PHILLIPS, JUDY	CHAUTAUQUA	YES	60		LANDOWNER DECIDED TO CONTINUE RENTING TO AREA FARMER
PULCI, ANN	CHAUTAUQUA	YES	60		HUSBAND DIED. WAS IN TOMATOES. NOT PLANTED IN 1998.
PANNELLA, GEO.	CHAUTAUQUA	YES	300		OFFERED TO RENT 30 ACRES. OWNER DECLINED OFFER. WOULD RECONSIDER IF WE TOOK A LARGER ACREAGE.
BROWN, RANDY	CHAUTAUQUA	NO	20		THINKING OF BUILDING A GOLF COURSE
REISCH, RICHARD	CHAUTAUQUA	YES	50		MOWED IN 1997. IN LOW BRUSH PREVIOUSLY
HANBY, DON	CHAUTAUQUA	NO	50		SOME STEEP AREAS. NEAR STOCKTON.
ZINK	CHAUTAUQUA	YES	135		CRP. WEIGHT LIMITS?? SLOPE??
SAM, CHARLES	CHAUTAUQUA	NO	75		UNSUITABLE BECAUSE OF WEIGHT LIMITS ON ROAD.
NEWCOMB, BARB	CATTARAGUS	NO	10		HERBICIDES MAY BE A PROBLEM.
LORE, DEBORAH	CHAUTAUQUA	YES			UNSUITABLE. MOST IS BADLY OVERGROWN.
ROMANOWSKI, J.		NO	10		NO INFO ON THIS GUY. STACY SHOULD KNOW MORE.
CHERRY, NORM	CHAUTAUQUA	YES	59		UNSUITABLE. BADLY OVERGROWN.
FIELDS, PAUL	CHAUTAUQUA	YES	8		ODD SHAPED FIELD.
FRALLICK, JIM	CATTARAGUS	YES	55		TAKING A WAIT AND SEE ATTITUDE.
SCHALLMO	CATTARAGUS	YES	40		LAND LOOKS OK. LONG WAY FROM DUNKIRK. WEIGHT LIMITS??
HITE, RONALD	CATTARAGUS	NO	60		FALLOW LAND. LONG WAY TO POWER PLANT.
ROSATI	CHAUTAUQUA	YES	40		UNSUITABLE. SLOPE PROBLEMS
KACZMAREK, CHRIS	CHAUTAUQUA	NO	35		~10 MILES TO PLANT
EADES, TIM	CHAUTAUQUA	NO	53		~30 MILES TO PLANT
MURDOCH, DAVID	CATTARAGUS	NO	10		30 MILES TO PLANT
WIESNER, RUDY	CHAUTAUQUA	YES	25		2 FIELDS TOTALING 15 ACRES LOOK USABLE. THIS IS QUITE DISTANT FROM ANY OTHER OF OUR SITES.
THIEL, DAVID	CATTARAGUS	NO	45		~40 MILES TO PLANT. INTERESTED IN BEING A GROWER
MITCHELL, MARG.	CHAUTAUQUA	YES	90		ACCESS DRIVEWAY IS VERY STEEP.
CACKENER, JOHN	CHAUTAUQUA	YES	38		TOOK A QUICK LOOK FROM THE ROAD. NEED MEET WITH OWNER ON A FUTURE TRIP.
NOBLES, SCOTT	CATTARAGUS	NO			LITTLE INFO ON THIS PERSON
WHITE, BILL	CATTARAGUS	NO			BETWEEN RANDOLPH & CONEWANGO
SMITH, RICHARD	CHAUTAUQUA	NO			LITTLE INFO ON THIS PERSON
REID, ANN	CATTARAGUS	YES	100		SOME FIELDS APPEAR USABLE. NEED TO CHECK ROAD WEIGHT LIMITS
SNYDER, WILLIAM		NO	18		TOWN OF IRVING
RICE, JAMES		NO	20		NEAR FREWSBURG
Total Prospective			***1,985***		
Total Acreage			**2,496**	**297**	

APPENDIX B
Schedule of Task Deliverables

Key Deliverables and Milestones from WBS

Updated 3/14/00

Task 1: Feddstock Production and Infrastructure Development

Task/Deliverable	Responsibility	Original Date Due	Est. Due Date	Submission Date
Grower's Handbook - Update	SUNY ESF	November 2000	September 2001	
Grower's Handbook - Final	SUNY ESF	September 2002	March 2003	
Nursery Production Guidelines - Final	SUNY ESF	September 2001	September 2001	
Field Operations Letter Reports	FORECON	To accompany invoice for each major field operation		
Monthly Progress Report	SUNY ESF, RC&D, FORECON	15th of the next month	15th of next month	
Model Grower Contracts - Draft	SoCNY RC&D	June 1998	June 1998	
Model Grower Contracts - Final	SoCNY RC&D	September 99	March 2000	March 2000
Grower Survey Reports	SoCNY RC&D	Semiannually	Annual December 2000	

Task 2: Power Plant Conversion & Testing

Task/Deliverable	Responsibility	Original Date Due	Est. Due Date	Submission Date
Installation and Shakedown Test Report for Dunkirk Cofiring System	NMPC	December 1998	June 2000	
Annual Performance and Cost Report for Dunkirk Cofiring - Annually	NMPC	October 1999	<----------October 1998---------->	
Willow Gasification report	BED	September 1999	September 2001	

Task 3: System Optimization and Experimental Studies

Task/Deliverable	Responsibility	Original Date Due	Est. Due Date	Submission Date
Genetic Improvement Interim-Program Report	SUNY ESF	October 1999	October 1999	March 2000
Genetic Improvement - Final Report	SUNY ESF	December 2000	December 2000	
Clonal Trial and Studying the Ecophysiological Basis for the Relative Productivity - Interim Program Report:	SUNY ESF	September 1999	September 1999	March 2000
Clonal Trial and Studying the Ecophysiological Basis for the Relative Productivity - Final Report	SUNY ESF	December 2002	December 2002	
Clone Site Testing and Selection for Scale-up Plantings - Interim Program Report	SUNY ESF	March 1999	June 2000	
Clone Site Testing and Selections for Scale-up Plantings - Final Report	SUNY ESF	February 2001	February 2001	
Alternative Methods of Site Preparation - Interim Program Report	SUNY ESF	December 1999	June 2000	
Alternative Methods of Site Preparation - Final Report	SUNY ESF	April 2001	April 2001	
Application of Poultry Manure on Willow Biomass Crops - Interim Program Report	SUNY ESF	July 1999	July 1999	March 2000
Application of Poultry Manure on Willow Biomass Crops - Final Report	SUNY ESF	December 2000	December 2000	
Use of Biosolids as Organic Soil Ammendment in Willow Bioenergy Plantations - Interim Program Report	SUNY ESF	October 1998	July 1999	March 2000
Use of Biosolids as Organic Soil Ammendment in Willow Bioenergy Plantations - Final Report	SUNY ESF	December 2000	December 2000	
Effect of Slow-Release Nitrogen Fertilization on Aboveground Biomass Production - Interim Program Report	SUNY ESF	April 1999	March 2000	March 2000
Effect of Slow-Release Nitrogen Fertilization on Aboveground Biomass Production - Final Report	SUNY ESF	January 2001	January 2001	
Integrated Pest Management in Willow Biomass Crops - Interim Program Report	SUNY ESF	October 1998	March 2000	March 2000
Integrated Pest Management in Willow Biomass Crops - Final Report	SUNY ESF	December 2000	December 2000	
Aboveground Biomass Equation Development for Salix and Populus - Interim Program Report	SUNY ESF	October 1998	October 1999	March 2000
Aboveground Biomass Equation Development for Salix and Populus - Final Report	SUNY ESF	February 2001	February 2001	
Effect of Storage Conditions on the Survial and Growth of Willow Cuttings - Final Program Report	SUNY ESF	February 1999	March 2000	March 2000
Evaluation of Step Planter Report- Final Report	Cornell ABEN	September 1998	September 2000	
Planter System Optimization Report - Final Report	Cornell ABEN	September 1998	September 2000	
Harvester Optimization - Final Report	Cornell ABEN	February 2000	March 2003	
Supply Dynamics Optimization - Final Report	Cornell ABEN	October 2000	March 2003	
Impact of Willow/Poplar Biomass Crops on Diversity of Soil Microarthropods - Interim Program Report	SUNY ESF	June 1999	October 1999	March 2000
Impact of Willow/Poplar Biomass Crops on Diversity of Soil Microarthropods - Final Report	SUNY ESF	December 2002	December 2002	
A Study of Avian Biodiversity in Short Rotation Intensive Culture Willow Plots - Interim Program Report	Cornell ORN	October 1999	September 1999	September 1999
A Study of Avian Biodiversity in Short Rotation Intensive Culture Willow Plots - Final Report	Cornell ORN	December 2002	December 2002	
Root Dynamics in Willow Biomass Crops - Interim Program Report	SUNY ESF	October 1999	December 2000	
Root Dynamics in Willow Biomass Crops - Final Report	SUNY ESF	February 2001	March 2001	
Soil Sustainability and Productivity. In Short Rotation Intensive Culture Willow and Poplar - Interim Program Report	SUNY ESF	September 1998	October 1999	March 2000
Soil Sustainability and Productivity. In Short Rotation Intensive Culture Willow and Poplar - Final Report	SUNY ESF	December 2000	December 2000	
Power Production Performance Research Final Report - Annual	NRG	January 1999	January 2001	January 2001
Environmental Studies Report - Annual Reports	NRG	November 1998	November 2000	November 2000

Task 4: Enterprise Development

Task/Deliverable	Responsibility	Original Date Due	Est. Due Date	Submission Date
Biomass Energy Incentives Report	SRC	June 1998	June 1998	June 1998
Annual Reports on CRP Usage - Annually	SoCNY RC&D	December 1998	March 2000	March 2000
Willow Markets Research Report - Preliminary	SoCNY RC&D	June 1999	March 2000	March 2000
Willow Markets Research Report - Final	SoCNY RC&D	June 2000		
Updates for Willow Systems Business Analysis - Annually	Antares	November 1998	June 2000	
Cooperative Business Structures Report	SoCNY RC&D	November 1998	August 2000	
Business Start-up Articles of Incorporation and Plan for Production Equipment Owners	Antares	June 2000	December 2000	
Community Meetings on Willow Energy Development (Summary and attendees)	SoCNY RC&D	September 1998	<----------October 1999---------->	
Willow Biomass Newsletter - Semi-annual	SUNY ESF	March 1998		
Willow Biomass Web Page - Operational	SUNY ESF	June 1998	June 1998	June 1998
Biomass Bioenergy Advisory Board (summary and attendees) - Annually	SUNY ESF	June 1998	June 1998 - 1999	June 1998 - 1999
Quarterly Progress and Financial Reports - Quarterly	Antares	April 1998		
Biomass Field Days - Annually	SUNY ESF	August 1998		
Consortium Program Overview and Annual Review - Annaually	Antares	January 1999	<----------May 1999---------->	

APPENDIX C
Press Releases, Newsletters, Magazine Articles, Presentations

ABSTRACTS FOR RECENT PAPERS

Carbon Enrichment in Soil Physical Fractions in Short-Rotation Intensive Culture (SRIC) Systems

F. Ulzen-Appilah and R.D. Briggs, L. Abrahamson and D. Bickelhaupt.
State University of New York, College of Environmental Science and Forestry.

Short rotation intensive culture (SRIC) systems of willows (*Salix*) and poplars (*Populus*) provide biomass energy, sequester carbon in litter and below ground root biomass and have potential to increase soil organic matter. Physical fractionation of soil into particle size classes present important research tools that can be used to study soil organic matter build up. The use of carbon enrichment ratios facilitates the comparison of organic matter associated with particle size classes from different soils. This paper compares fractional carbon concentration, content and enrichment ratios in willow biomass and adjacent grass and non-woody vegetation (control) plots to evaluate carbon storage.

F. Ulzen-Appiah, (315) 470-6775, fulzenap@mailbox.syr.edu

Microbial Biomass Carbon in Short-Rotation Intensive Culture (SRIC) Systems

F. Ulzen-Appiah and R.D. Briggs, L. Abrahamson and D. Bickelhaupt.
State University of New York, College of Environmental Science and Forestry.

Soil organic matter is a key determinant of soil fertility and productivity because it influences many important soil properties. Knowledge of changes in soil organic matter in SRIC systems would aid our understanding of soil productivity and sustainability in SRIC systems. Evidence suggests soil microbial biomass is an actively cycling organic matter pool, is more sensitive to changes in soil organic matter than is total organic matter and could be used as a sensitive indicator of change and future trends in soil organic matter levels. This paper discusses soil microbial biomass carbon in SRIC plots over time. The plots are located at Tully, Lafayette, Milliken, Kintigh and Massena in New York and provide an array of different root stock ages (<1, 4, 7, and 10 y) and span a wide range of treatments (fertilization, irrigation, clones and cutting cycles).

F. Ulzen-Appiah, (315) 470-6775, fulzenap@mailbox.syr.edu

Effect of Temperature of Mineralization of Nitrogen from Sewage Sludge and poultry Manure Compost

H.G. Adegbidi and R.D. Briggs
State University of New York, College of Environmental Science and Forestry.

An incubation study was conducted to access temperature effects on N mineralization from

organic residuals. Four temperature levels (10, 20, 30 and alternating 30/10 · C every 12 hours), and 2 organic residuals (sewage sludge, composted poultry manure) plus a control were used. Sand-filled plastic columns were top-dressed with 2.5 cm layer of organic residual or left bare (control). Within each column either cation- or anion exchange resin acted as sinks for leached mineral N. After 31 days, mineral N contents of the resin, sand and soil solution of each column were determined. Rate and production of mineral N were calculated. Mineral N increased with increasing temperature. Mineral N produced was similar for the 20 and 30/10 · C temperatures that have the same heat input, but NO_3-N proportion was higher with the 20 · C temperature. Nitrogen mineralization rate was highest around 20-25 · C and estimated at 3-4% of applied TKN.

Hector Adegbidi, (315) 470-4742, hgadegbi@mailbox.syr.edu

Fertilization of Short-Rotation Woody Crop Plantation with Slow-Release Nitrogen

B.D. Ballard and R.D. Briggs
State University of New York, College of Environmental Science and Forestry.

The use of wood for energy production has received increased attention in recent decades as alternative sources of clean, renewable energy are being explored. Short-rotation woody crop plantations of fast-growing trees such as willow and poplar have the potential to meet some of these fuel needs. Fertilization with nitrogen will improve yields in many plantations and will contribute to the sustainability of the system by replacing nitrogen removed from harvesting of the crop. In this study, three fertilization rates, 100, 200, and 300 kg N/ha, and a control were used to evaluate the impact of nitrogen fertilization on third-year yields of five willow clones and one poplar clone in three plantations across New York State. Response to fertilization differed by site, and tree biomass response was a function of survival, weed competition, site and microsite variation, and their interactions. Future work should focus on these interactions.

Benjamin D. Ballard, (315) 696-6935, bdballar@mailbox.syr.edu

A STUDY OF AVIAN BIODIVERSITY IN SHORT ROTATION INTENSIVE CULTURE WILLOW PLOTS

OCTOBER 1999

Abstract: *Birds were censused in fifteen SRIC-plots located in six sites in NY State from April through September 1999. These plots were planted with willow clones one to three growing seasons old. Different clones or groups of clones were planted in each plot. A total of 31 bird species were censused. Sixty eighth nests of nine different species were found.*

In this progress report we present preliminary results on the avian biodiversity in the 1999 season. We list the bird species observed per plot and per willow age class. We also provide information on nests found and compare with last year's results.

Area of study and methods

This study was conducted in fifteen plots located in the following sites in NY State: King Ferry, Tully, Lafayette, Canastota, Leon, and Sheridan. Table 1 summarizes available information for each plot, including site, field, area, planting date, age of plants, and number of different clones.

Table 1. Plots studied. 1999.

Site	Field	Area (ac)	Planting Date	Age (years)	# Clones
King Ferry	Barn Site	5.5	1996	3	8
	Weather St.	3.7	1996	3	7
	Site Trial*	2.7	1995	1	14
Tully	Area 4**	0.1	1987	3	300
	Area 12*	2.7	1995	1	8
Lafayette	Lafayette Rd.	7.0	1997	2	5
	Upper Field	2.0	1998	1	6
	Lower Field	2.0	1998	1	3
Canastota	Canastota	20.0	1998	1	7
Leon	Western Field	17.0	1998	1	2
	Field by Gas Well	16.0	1998	1	5
Sheridan	Smith	67	1998	1	5
	A. Hopkins		1998	1	4
	Western Field		1998	1	1
	Eastern Field		1998	1	4
age 1 – all	11 sites	129.4			
age 2 – all	1 sites	7.0			
age 3 – all	3 sites	9.3			

*These plots were harvested before we have started visiting in April.
**Area 4 was just partially harvested.

Data was collected from April – September 1999, covering the whole season. This contrasts with last year, when data recording started only in July.

Each plot in King Ferry and Lafayette was visited 20 times at least one week apart. Because of the very small size of the plants in Canastota, Tully, Sheridan, and Leon, 10 visits were made to each plot in these three areas.

We used, spot-mapping techniques to census birds during each visit (Robbins et al. 1970 and Bibby et al. 1992) the same one used the years before. Different procedures were used depending on the age of the plot. For first year plots, we walked transects through the plots, mapping the locations of each bird that was seen or heard in or near the plots. For the second and third-year plots, we walked the perimeter of the plot mapping any birds detected and afterwards we walked transects through the plots. This procedure was adopted to minimize as much as possible disturbances due to walking through dense and tall vegetation. Every tree with a nest were flagged, making easy to track the same nest and follow the nestling development.

The species detected in or near plots were divided into three categories: breeding species, visitors to the plot, and neighbors or potential visitors. *Breeding* included only birds which nests were found. *Visitors* are species actually seen or heard inside the plot but not meeting the previous definition. *Visitors* were divided into two groups: territorial birds that are possible breeders, and transients, that use the plots for feeding, but were only observed after the breeding season was over. In a later data analysis we will quantify the number of territories of each species and estimate their density. *Neighbors* are species that are detected near or flying over the plot and not previously listed. In this report we will not address the neighbors.

Results

Tables 2-4 present the results of the bird species observed grouped by the age of the willows growing in each plot. Table 5 presents the results on nesting per plot and Table 6 per clone.

Table 2- First Willow Growth Season
In 1999, no breeding species were found in the willows in their first growing season. This contrast with results from 1998 season, in which American Goldfinch was a breeder. Among visitors, we recorded 15 species.

Table 3 - Second Growth Season
This year Laffayette Rd was the only plot in the 2nd growing season. In this plot, six breeding species were found four of which (American Goldfinch, American Robin, Cedar Waxing and Gray Catbird) already recorded in a 2nd year plot last year. In additional 13 visitors species were recorded. Nests of two early breeders, Killdeer and a Song Sparrow, were found on the ground. This year Brown headed Cowbird were found as visitors.

Table 4 - Third Growth Season
There were 3 plots in 3rd growth season (Table1). Although the 1998 and 1999 plots in this category were not the same, the breeders species recorded were the same in both years. A total of ten species were found as Visitors.

Table 5 - Nesting
Details about the numbers of nests per plot are given in Table 5. All nests found in 1999 season were in 2- or 3-year old willows. Nests of nine species, including American Goldfinch, American Robin, Cedar Waxwing, Gray Catbird, Killdeer, Red-winged Blackbird, Song Sparrow, Willow Flycatcher, and Yellow Warbler were found.
Although the sample size is small, the data suggest that the density of nests is higher in 3 rd-growing season plots (4.4 nests per acre) than in 2 nd season plot (3.8 nests per acre)

Table 6 – Clones.
American Goldfinch nests were found in 6 different clones. Most of the nests of the other species listed above were found in clone S365, probably because the branching patterns provide best nest site.

Conclusions

The results for the 1999-breeding season produced results roughly similar to these obtained in similar habitat in 1998 and 1997, although more breeding species have been found.

This preliminary analysis of the 1999 breeding season shows that in the willow plantations nest density, and hence presumably breeding density, increases with the age of the willows. More data will be needed to determine to what extent plot size has an effect on bird density.

References

Bibby, C.J., N.D. Burgess, and D.A. Hill. 1992. Bird census techniques. Academic Press, San Diego, California.

Robbins, C.S., and International Bird Census Committee. 1970. Recommendations for an international standard for a mapping method in bird census work. Audubon. Field Notes 24:723-726.

Table 2. Bird species observed in plots in their 1st year of growth.

Breeding	Visitors
No nest found	American Robin
	Baltimore Oriole
	Bobolink
	Chipping Sparrow
	Common Grackle
	Field Sparrow
	House Sparrow
	Indigo Bunting
	Killdeer
	Mourning Dove
	Northern Cardinal
	Red-winged Blackbird
	Savannah Sparrow
	Song Sparrow
	Vesper Sparrow

Table 3. Bird species observed in plots in their 2nd year of growth.

Breeding	Visitors
American Goldfinch	Black-capped Chickadee
American Robin	Brown-headed Cowbird
Cedar Waxwing	Chipping Sparrow
Gray Catbird	Common Yellowthroat
Killdeer	Dark Eye Junco
Song Sparrow	European Starling
	Field Sparrow
	House Finch
	House Wren
	Indigo Bunting
	Mourning Dove
	Willow Flycatcher
	Yellow Warbler

Table 4. Bird species observed in plots in their 3rd year of growth

Breeding	**Visitors**
American Goldfinch	Alder Flycatcher
American Robin	Baltimore Oriole
Cedar Waxwing	Black-capped Chickadee
Gray Catbird	Common Yellowthroat
Red-winged Blackbird	Eastern Phoebe
Willow Flycatcher	Field Sparrow
Yellow Warbler	Northern Cardinal
	Red-winged Blackbird
	Song Sparrow
	Wood Thrush

Table 5. Number of nests by plot.

Plot	Lafayette rd	Barn Site	Weather Station	Area 4	**Total**
Willow growth season	2nd	3rd	3rd	3rd	
Plot size (ac)	7.0	5.5	3.7	0.1*	
Bird Species					
American Goldfinch	17	3	2	2	**24**
American Robin	1	13	5		**19**
Cedar Waxwing	6			1	**7**
Gray Catbird	1	5	1	1	**8**
Killdeer	1				**1**
Red winged Blackbird			3		**3**
Song Sparrow	1				**1**
Willow Flycatcher				1	**1**
Yellow Warbler		1	2	1	**4**
Total	**27**	**22**	**13**	**6**	**68**
Nests/ac	*3.8*	*4.0*	*3.5*		

*area partially harvested. We do not know exactly the real size of this plot.

Table 6. Clones in which nests were found, (all plots).

Bird Species	Nm6	S301	SV1	SV/ NM6	Clone/site	S365	SA2	S25
American Goldfinch	*			*	*	*	*	*
American Robin	*		*		*	*	*	
Cedar Waxwing				*	*			
Gray Catbird	*	*	*	*				
Killdeer				*				
Red winged Blackbird						*		
Song Sparrow		*						
Willow Flycatcher						*		
Yellow Warbler						*		*