ASSESSING PURPOSE-GROWN BIOMASS PRODUCTION ON FIRST NATIONS

Prepared October 2013 by:
Doug Macpherson, External Programs Co-ordinator
Indian Agricultural Program of Ontario
www.indianag.on.ca

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Acknowledgements

The Indian Agricultural Program of Ontario initiated this discussion on purpose-grown biomass grass production for First Nations farmers. The financial support of the Agricultural Adaptation Council has enabled the development of this document. Financial support from the Aboriginal Agricultural Initiative has enabled the establishment of two biomass grass test sites. Both programs are funded through Agriculture and Agri-Food Canada. Test site results are included in this discussion. We thank our site cooperators for their dedication to the project. They are Tahgahoning Enterprises Incorporated on Walpole Island First Nation, and Barry Hill owner of Hillsfield Farms on Six Nations of the Grand River. As the sites mature, additional information will become part of this document.

Information has been obtained by researching several publications and studies (see References on page 46).

We acknowledge the ongoing support of industry, Ontario Federation of Agriculture, Ontario Soil and Crop Improvement Association and the Biomass Field Trial Steering Committee. *(See Appendix A)*

The Board and staff of Indian Agricultural Program of Ontario are pleased to support the continued development of First Nations agriculture in Ontario in this manner. It is hoped that this document will further empower First Nations communities to introduce purpose-grown biomass grasses into their farm businesses as market opportunities develop.

Agriculture and Agri-Food Canada

Agricultural Adaptation Council

Aboriginal Agriculture Initiative

Preface

A progressive agricultural sector exists on Ontario First Nations. In the past quarter century agriculture on First Nations has evolved and changed in conjunction with many other Ontario rural communities. Many small family farms have evolved into larger businesses that control larger land bases and require more credit.

In some areas First Nations crop enterprises struggle to maintain adequate crop rotations and sustainable economic yields. In these areas, poorly maintained municipal drains, lack of sub surface drainage and predominantly clay soil types limit the variety and acreage of crops that can be grown. Corn is grown very selectively and on only the best soils to ensure that the crop is profitable. Hay is an alternative crop but hay stands over the long term struggle to maintain the adequate legume content desired in the marketplace. Northern communities are further limited by lack of heat units and a short growing season. These production challenges have resulted in several thousand acres of land that is not intensively farmed. There are also a substantial number of acres with reduced production potential from years of intensive cropping. These acres are in need of a perennial forage crop.

Purpose-grown biomass crops may be an alternative crop for First Nations farmers however the agronomic challenges of growing such crops on soils in these communities requires some assessment. Assessing Biomass Production on First Nations project will help position the sector for involvement in the production of purpose-grown biomass as profitable markets develop.

The Indian Agricultural Program of Ontario (IAPO) has worked with First Nations farmers since 1984. IAPO is a valuable source of capital and operating credit to the sector. IAPO-delivered agriculture extension programs further strengthen a growing number of First Nations agricultural businesses. In response to the need for improved rotations and better cash flows IAPO recognizes the need for new opportunities and has committed to facilitating this study.

Funding was obtained from the Ontario Agricultural Adaptation Council and the Aboriginal Agricultural Initiative. Indian Agricultural Program of Ontario also contributed financially and was the lead project. To maximize the results of this project, a Biomass Field Trial Steering Committee *(Appendix A)* was organized. The Steering Committee oversaw all aspects of the two field trials.

Project Goals: Assessing the Potential of Biomass Production on First Nations has two goals:

1.) Document successful agronomic systems and assess production potential where soil texture and drainage offer unique production challenges for selected agricultural crops.
2.) Develop an agronomic/economic assessment of all aspects of growing, harvesting, processing and marketing purpose-grown biomass crops on First Nations in Southern Ontario. The model will be a decision making tool for First Nations farmers who are contemplating participation in future purpose-grown biomass production.

The sector relies on the Indian Agricultural Program of Ontario and agricultural suppliers to fill the voids of information transfer. The preparation of a business model for First Nations should not be seen as duplication of information already at hand. In fact the results of this project will enable First Nations farmers and their communities to respond to the emerging opportunity of growing agricultural crops for biomass. This business model will be made available to the First Nations agricultural sector at the project's conclusion. IAPO is well connected to Ontario First Nations communities through their Economic Development Officers. The study will be forwarded to this group. Study results will appear on the IAPO website and be discussed at community agricultural events and tours. Information will be shared with Ontario farmers through the Ontario Ministry of Agriculture and Food, Ontario Federation of Agriculture, and the Ontario Soil and Crop Improvement Association.

The First Nation Biomass Business Model details the processes involved to establish purpose-grown biomass crops on First Nations. The Ontario industry at the time of preparation of this document remains in the developmental stage. Much has been achieved in regard to agricultural practice but end product markets and subsequent end use remains fragmented and below expectations. Band Councils, community groups and First Nation farmers can utilize many of the processes and information sources discussed in this document.

The experience resulting from two First Nations field trials currently underway in Southwestern Ontario supplement this report. The two trials are:

Six Nations Trial: This trial is 17 acres of switchgrass grown by cooperator Barry Hill, owner of Hillsfield Farms. The trial implemented seeding and harvesting techniques deemed appropriate for undrained clay soils. Other parameters were documented as well. The trial was seeded in the spring of 2013 and is ongoing. Harvest information will be added to this report once that information is available.

Walpole Island Trial: The cooperator is Tahgahoning Enterprises Incorporated; a band owned corporation that farms 5000 acres of land on the Walpole Island First Nation.

This trial is 21 acres in size. Acreage has been seeded to three species: switchgrass, miscanthus and a multi-species mixture of Tall Grass Prairies (TGL) most of which are native to Walpole Island First Nation. The trial is ongoing and to date has focused on field processes as well as production comparisons between the species grown. The cooperator has interest in pelleting of biomass for community use and utilizing purpose-grown biomass crops as buffers along the many miles of agricultural drainage canals that exist on Walpole Island First Nation.

Location of Field Trials
Walpole Island and Six Nations

Executive Summary

Production of purpose-grown biomass grasses in First Nations communities is a possibility. Significant land area for biomass production is available. Agronomic practices and economic experiences from two First Nations test locations have been included as part of the discussion. Growing practices are detailed and basic information about the requirements of establishing, growing, harvesting and marketing a purpose-grown biomass grass is provided.

The five southern most First Nations Districts are made up of forty five First Nations communities. Our research concluded that land available for agriculture in these five districts would total 125,000 acres. IAPO information would suggest that First Nations entrepreneurs control approximately 40,000 acres with an additional 25,000 acres being leased to non-aboriginal farmers. The remaining 60,000 acres is not intensively farmed at this time. It is conceivable that First Nations could sustain purpose-grown biomass acreage of up to 60,000 acres if fifty per cent of the 125,000 acres of First Nations agricultural land was converted to purpose-grown biomass grass production.

First Nations purpose-grown biomass producers must pay strict attention to cost control as demonstrated in the discussion. Results from the growing sites at Walpole Island and Six Nations will be helpful in benchmarking production best practices and yield potential. It appears that First Nations Famers can be competitive with cost of production. Switchgrass cost of establishment in this study was equal to or lower than Ontario average. The ease of establishment of switch grass renders it the crop of choice for the First Nations sector at this stage of crop research. Developments that will lower the cost of seeding of miscanthus could change this in the future.

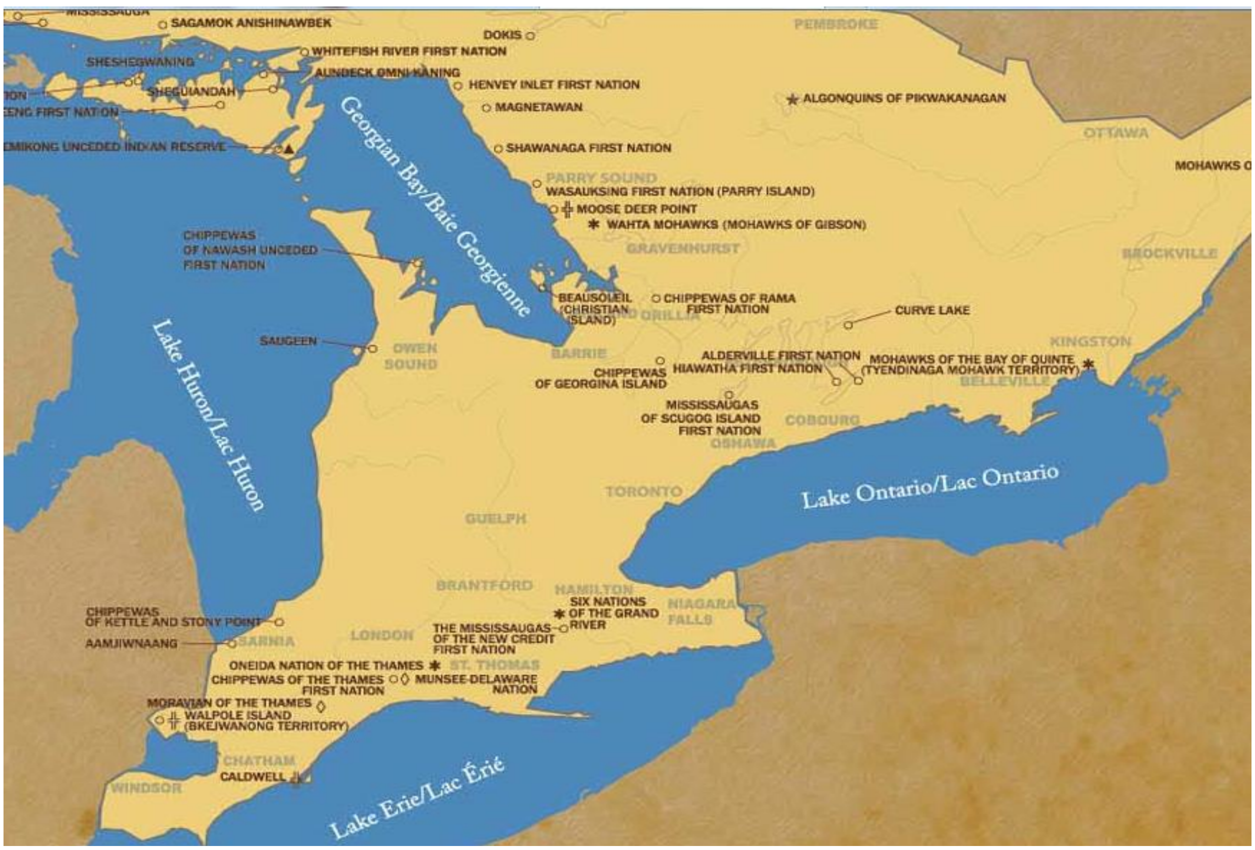
Profitable markets are the key to growth. At this time, most product demand stems from local niche markets that can sustain relatively small production units. Larger markets such as with Ontario Power Generation have failed to materialize. Development of cellulosic ethanol processes and products made from biocomposite materials are taking place but have failed to generate significant raw product demand. Despite the current lack of positive economic news, First Nations farmers must keep abreast of new develops in purpose-grown biomass production. Purpose-grown biomass crops like switchgrass would be a positive addition to First Nations farmer’s crop rotations.

In summary, First Nations farmers and communities can successfully grow purpose-grown biomass grasses. Low cost agricultural land is available for this purpose. The inhibiting factor remains the absence major markets for the raw product.

Potential First Nations Farmland Available for Biomass

There is a general misconception that First Nations lack the basic soil and geo-climatic attributes to make viable agriculture possible. This is simply not the case as several thousand acres of viable farmland is available for agricultural development. A small but viable agricultural sector does exist on Ontario First Nations. One of the goals of this business model is to assess the potential of First Nations farmers to become significant producers of biomass products. Assessing this potential is difficult because of the lack of data regarding the sector. Since all First Nations based farms are exempt from reporting to the Canada Revenue Agency, there is little historical data from that source.

Agricultural Land by District



Ten First Nations Districts exist in Ontario. For the purposes of this discussion we have focused on the following five Ontario First Nations Districts: London, Brantford, Bruce, Peterborough, and Sudbury.

The remaining Districts of Fort Francis, James Bay, Kenora, Lake Head, and Sioux Lookout have limited potential for sustainable agricultural production and purpose-grown biomass crop production. Many Northern and northwestern communities in these districts will have greater biomass production potential in wood related biomass products.

J. Phillip Nicholson of the Massachusetts Institute of Technology produced a thesis in 1984 entitled “Agricultural Potential on Indian Reserves in Ontario.” Nicholson’s work provided data that remains pertinent to the First Nations agricultural sector today. After researching data from several sources Nicholson determined that the five districts of Branford, London, Sudbury, Peterborough and Bruce contained 173,220 acres of active farmland .Nicholson further determined that 32 of the 45 First Nations in these districts have land with agricultural potential. The Nicholson determination by district is as follows:

Farm Land Suitable for Agriculture		
District	**Communities in District**	**Acres**
London	7	51910
Brantford	2	35591
Bruce	2	17604
Peterborough	13	28492
Sudbury	21	39623
Total	**45**	**173,220**

The acreage above includes land classes one – four plus organic as determined by the Canada Land Inventory. Since the publishing of Nicholson’s statistics in 1989, changes have occurred in many of these territories. A few First Nations have expanded the size of their communities through land acquisition. On the other hand significant First Nations population growth has increased urbanization on First Nations resulting in the loss of land available for agriculture. Much fragmentation of agricultural land has occurred as most First Nations have not implemented land use or zoning plans. A housing sprawl is often evident. When one accounts for these factors and wood lot acres, the area available for cleared for agriculture is estimated to be 125,000 acres.

Current First Nations Agriculture Activity and Capacity

Agriculture capacity in terms of current farming activity varies significantly from First Nations to First Nations. IAPO data and experience suggests that there are up to 400 First Nations farmers in Ontario with most existing in the five Ontario First Nations Districts listed above. Current agricultural businesses have a projected land base of 40,000 acres. An additional estimated 25,000 acres of First Nations land is leased to non-aboriginal farmers.

In summary, the First Nations agricultural sector has the capacity to convert significant acres to purpose- grown biomass crops. When considering both farmed and non farmed acres it is conceivable that purpose-grown biomass acreage could be as much as 60,000 acres or roughly 50 percent of the total acres that are suitable for agricultural production.

Agronomic Challenges

The productive potential of First Nations soils varies greatly. In the Brantford and London Districts undrained clay based soils predominate. In other regions loamier soil types are easier to work but are only naturally drained. Historical yields of soybeans, wheat and corn on many First Nations farms lag behind provincial averages. Sustainable crop enterprises remain in these areas due to reasonable property values and low land rents. While some of Ontario’s most productive soils have land values in excess of ten thousand dollars and demand land rents of over three hundred dollars per acre, First Nations values are much less. Rental rates for naturally drained clay soils on First Nations currently averages much lower. These lower land costs create an economic advantage for First Nations farmers.

Agronomics for Establishing Purpose-Grown Biomass on First Nations

Where to Grow

Farmers face many of the same decisions whether deciding to grow a corn crop or a purpose-grown biomass crop such as switchgrass. The decision making process for the two field trials is documented to act as a guide for use on any First Nations farm. Soil type, drainage, fertility, length of the growing season and local markets must be carefully coordinated with species and variety selection. It is hoped that the results of these trials will assist future purpose-grown biomass producers to formulate their own growing template and business model.

Field Selection

The fields chosen for the field trials included in this report have many of the variables farmers on First Nations will experience.

- Six Nations Site: The Barry Hill site was chosen as representative of many other fields in the area. The site has been in a mostly two crop rotation of wheat and soybeans for many years. Soil type is variable ranging from clay loam to predominately Haldimand clay. The location is naturally drained and has wet areas where ponding does occur. The gently rolling topography is representative of the region. The field's 17 acres are bordered by trees to the west and north. The following site map (on the right) shows these topographical features. The photo on the left is of the previous crop of soybeans grown in 2012.

2012 Soybean Crop

Satellite View of Six Nations Site

- Walpole Island Site: This site is representative of undrained and less productive acres on the island of Walpole. The 21 acre field is flat with a silt/clay soil type common to the region. Crop rotation has been corn and soybeans for the chosen location. The last crop prior to seeding was soybeans. Natural drainage of the area usually results in wet soggy spring conditions following by droughty areas during summer dry spells. The field is pictured below.

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Satellite View of Walpole Site

Species and Variety Selection

It must be ensured that the species and variety selected will perform at the selected location. Drainage, soil type, and overwintering ability of the crop are major considerations. Biomass seed and rhizome suppliers have a wide range of species and varieties that have been evaluated for winter hardiness. Suppliers will have variety information to assist with species and variety selection. Information and experience from growers in the area can also be useful when choosing a variety.

Influencing Factors – Six Nations

A significant well capitalized farm sector is in place at Six Nations of the Grand River. The farmers in this area are accustomed to working with the region's clay soils. No till and minimum tillage are common practices. Crop rotations are mostly soybeans and winter wheat which is often under seeded to red clover. Red clover is left overwintered and harvested for seed the following season. A perennial grass has a place in this soil type and crop rotation.

On-farm experience with purpose-grown biomass crops to date indicates that switchgrass would be the best choice for this area. The cost of seed is reasonable at one hundred dollars per acre. Additional capital costs in the form of specialized equipment would not be required to seed switchgrass. There are greater variety choices that offer traits such as winter hardiness. The chances of success and the lower financial risk associated with switchgrass made it the purpose-grown biomass grass of choice for the Brantford site.

The area farmers have developed markets for hay and wheat straw. Switchgrass might offer opportunities in these markets in seasons when regular markets are not available or until such markets develop.

Influencing Factors – Walpole Island

Walpole Island First Nation (WIFN) possesses many natural areas that are home to several species of Tall Grass Prairie (TGP). These biomass grasses could provide erosion buffer strips around the farm's many drainage canal lined fields. The cooperator was interested in evaluating these TGP grasses against some of the more popular purpose-grown biomass grasses

WIFN's community owned band farm Tahgahoning Enterprises Incorporated Board of Directors are interested in value added opportunities associated with the biomass field trial. Biomass pellets could replace wood as a heat source for many in the community as natural gas is not currently available.

The soil type of the site is silty in nature. Growing conditions vary from extremely wet to droughty. In consideration of all of these factors the 21 acre site was divided between miscanthus, switchgrass and tall grass prairies.

About the Grasses Selected

Miscanthus

Miscanthus is currently the highest yielding purpose-grown crop producing biomass suitable for generation of power and heat through direct combustion. This herbaceous perennial grass requires a relatively low amount of nutrients and water. Once established miscanthus becomes perennial and can be productive with a stable yield for 10-15 years. Over 500 acres of miscanthus in Ontario have shown that a few varieties of this purpose-grown crop can be successfully grown in this climate and soil type with reasonable yields of 7.5 tonne/acre. Most miscanthus genotypes are sterile hybrids producing no viable seeds. Therefore, miscanthus is planted from either rhizomes or small plants called plugs. Miscanthus is usually planted in the spring at 6,000 rhizomes or plants/acre. Winter survival during the first year of establishment can be an issue for this crop in Ontario given the frequency of severe winters in some regions. Therefore, selection of an appropriate genotype or variety for a specific agricultural land is of critical importance for the successful establishment.

Although miscanthus grows fairly quickly, first-year growth is usually insufficient to be worth harvesting. The crop can be harvested from the second year onward. Miscanthus usually reaches a mature yield in the 4th year from establishment. After it is established, new shoots emerge in early spring and grow rapidly in summer to produce biomass.

Miscanthus leaves fall off in the winter, providing nutrients for soil. Almost leafless miscanthus can be harvested in winter or early spring. Leaving miscanthus to overwinter in the field partially leaches out nutrients which are usually unwanted chemicals in the combustion process of biomass. Further preprocessing may be required to remove unwanted nutrients in order to meet end-user fuel specifications. The establishment cost of miscanthus varies from $800/acre to $2,000/acre, depending on the price of rhizomes or plugs, royalties, soil types and equipment used. These cost estimates are constantly changing as sources of miscanthus rhizomes increase and planting procedures become more refined.

Agricultural organizations such as the Ontario Ministry of Agriculture and Food (OMAF) and Ontario Soil and Crop Improvement Association (OSCIA) have information for farmers on the selection of miscanthus varieties and crop establishment.

Switchgrass

Switchgrass is a perennial warm season grass native to North America. Like miscanthus, switchgrass offers low nutrient requirement and efficient water use. Since it is a native plant, switchgrass adapts to a wide range of soil types and has a good resistance to drought, pests and diseases. Once it is established, switchgrass will remain productive for 15-20 years with a stable yield. There are over 500 acres of switchgrass in Ontario at commercial and semi-commercial scales, providing biomass to space heating, animal bedding, and biocomposite material markets. The prominent advantage of switchgrass over miscanthus is that it can be easily established from seed, lowering the initial investment. Switchgrass can be seeded in the spring at a rate of 6 - 8 lbs/acre. Switchgrass can be seeded with a nurse crop such as spring wheat. This strategy can provide income from harvesting spring wheat in the summer during the first year of switchgrass establishment. There are a number of switchgrass varieties available for different climates and soil types, and extensive research and development in crop genetics is in progress. No switchgrass harvest can be expected during the first year of establishment. A low yield of about 1 tonne/acre may be produced in the second year. Switchgrass reaches its mature yield by the third year, and economical annual harvests can take place starting from the third year. Cutting switchgrass in the fall and baling in early spring is the preferred harvesting option to allow leach out of nutrients to soil in winter months. All farming operations for switchgrass can be done using existing farm equipment. The current yields of switchgrass varieties in Ontario range 3-6 tonne/acre at commercial and semi-commercial sites.

Tall Grass Prairies

Tall grass prairies (TGP) consist of mixed native plants, both tall grasses and nitrogen-fixing small plants. Producers growing TGP in Ontario have done so as a means of addressing soil erosion issues, restoring native plants for ecological reasons and increasing biodiversity habitat. There are over 3,000 acres of TGP in Ontario, mainly on non-crop land. The Walpole Island First Nation has interest in Tall Grass Prairies as a successful agronomic model that could be used to establish buffers along the many acres buffering the miles of irrigation canals that exist in their community. If a biomass market is created for TGP, expansion into some of the area's crop land is possible. Establishment of mixed prairie stands is more complex than establishing a monoculture crop and requires specialized planting equipment. There is no set definition for which species should be planted, and it is area-specific. There are over 40 species of native grasses and plants available for Ontario's land and typical establishment include many species. Similar to miscanthus and switchgrass, TGP are perennial and no biomass harvest occurs in the year of establishment. A small amount of biomass, possibly up to 1 tonne/acre, could be produced in the second year. Mature stands of TGP yield from 3-6 tonne/acre. Maturity is reached in the third year. Some TGP species can overwinter without decay. However, it is not certain that all TGP species could be left in the field in winter months without significant biomass losses. More field research is needed to determine the optimum harvesting schedule for TGP. Since the selection of TGP species and seeding is a specialized service at present, the establishment of TGP could cost up to $2,000/acre, depending on the topography of the land and species selected. If TGP are grown on field crop land at a large scale, the establishment cost could decrease to $1,000 per acre.

SPECIES COMPARISON SUMMARY			
	Miscanthus	**Switchgrass**	**Tall Grass Prairie**
Means of Establishment	Rhizome	Seed	Seed
Years to Maturity	4	3	3
Productive Years	10-15	15-20	10-15
Yield Range (tonnes)	highest	med-range	lowest
Preferred Soil Type	Best Soils	Adapts to less productive locations	For conservation & reclamation locations
Cost of Establishment	highest	least	mid-range

Establishment

Fall Preparations

Seeding purpose-grown biomass crops following a soybean crop is the most efficient means of establishment. There is little debris to hamper seeding and usually minimal weed control is required. However seeding into fields that have been hay, pasture or corn the previous year requires significant fall tillage to ensure an adequate seed bed is obtained in the year of seeding. Fall tillage would involve moldboard plowing or chisel plowing followed by cultivating to reduce crop residue and level the field. Hay or pasture fields will require that the crop be burned down with an application of glyphosate or a similar product on hay or pasture fields prior to fall tillage operations.

Spring Tillage Prior to Seeding

In all cases a level, firm, weed free site prior to seeding is the goal of the producer. The photo below shows a well prepared seed bed after cultivating and packing, prior to planting. Seedbed must be fine to ensure adequate seed to soil contact similar to seed bed preparations for grasses and legumes. A good seed bed promotes rapid germination and emergence. In testing for firmness, one rule of thumb is that foot prints in the prepared seedbed should indent less than ¼ of an inch. Packing the soil may be required after cultivation to achieve the desired firmness.

Purpose-grown biomass crops must be free of broadleaf weeds and rogue grasses. Achieving this desired pure stand begins with preplant field preparation. Careful preparation will rid the field of grasses and broadleaves. When given a good start, purpose-grown biomass grasses will successfully compete with and overcome the initial influx of undesirable species.

Walpole Island Preparations

Prior to the biomass seeding year, the field was seeded to soybeans. In mid-October, 2012 following soybean harvest, the field was assessed for weed growth. As the field was free of grasses and had only a minimal broadleaf infestation, no fall herbicide application was required. Soybean harvest conditions had been optimum and left the soil free of compacted and rutted areas. Fall tillage was not necessary.

The Walpole Island location was disced twice during the first week of June just prior to seeding. A packer was pulled behind the discs. The field was firm, level weed free and in good condition for seeding as evident below.

Six Nations Preparations

The Six Nations field had also been soybeans the year prior. No field preparations were required in the fall. There was little weed growth and no need for a pre-winter herbicide application. With a desired planting window of May 15 – May 31, the Six Nations plot was turbo tilled twice on May 15 to reduce weed pressure. The field was then cultivated twice and packed with a sprocket packer on May 26. These field operations resulted in a firm level ideal seedbed when seeded on May 28. Heavy rains began on May 28 so there was no need for packing the soil following seeding.

Fertility

General Comments

A fertility assessment of every field seeded to a purpose-grown biomass crop should begin with a soil test. The soil test can be taken the fall or in the spring prior to seeding. The soil test will provide a benchmark for field fertility as well as indicate fertility issues that need to be addressed prior to crop establishment. Potassium and phosphorus are not applied during the establishment year but are considered low at the following levels: less than 81 PPM for potassium and 10 PPM for phosphorus, according to OMAFRA guidelines for forage crops. Appropriate fertilizer is applied in the spring of year two.

Generally no application of nitrogen occurs in the establishment year as the nitrogen only stimulates weed growth and weed competitiveness. After establishment of purpose-grown biomass crops, only a minimal yearly application of nitrogen such as 50 to 75 pounds per acre is required. Since much of the plant's nutrient uptake of potassium and phosphorus that is required for plant growth is leached back into the soil prior to harvest no applications of these nutrients is required. Ontario fertility trials are now underway to determine if there is an economical yield response to the application of fertilizer, especially nitrogen, to established biomass crops. A soil test should be taken every three years after the establishment year. Fertility changes can be readily identified and recorded. A soil test will also indicate other essential criteria such as soil ph and organic matter.

Soil Test Results

Benchmark soil tests for the Six Nations field and Walpole Island field are pictured below. The circled figures indicate the areas of immediate interest. Potassium levels are below the accepted level of 81ppm. Phosphorus levels are not as critical but still on the low side of normal. Soil acidity or pH is acceptable in both cases. These low phosphorus and potassium levels will be addressed in year two with the application of a fertilizer blend that contains potash and phosphate. The exact analysis and amount required per acre will be determined at that time. The fertilizer supplier will assist with soil test analysis and fertilizer application recommendations.

TEI

Reported Date:2013-06-12 **Printed Date:**2013-06-12 **SOIL TEST REPORT** **Page:**1

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	Buffer	CEC meq/100g	% K	% Mg	% Ca	% H	% Na
WALPOLE	30364	4.5	22 L	36 L	34 VL	125 L	2160 VH	5 VL	7.8		11.9	0.7	8.7	90.5		0.2

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	Field ID
WALPOLE								3 VL	224	0.0 G		0.08	57	

SIX NATIONS

Reported Date:2013-05-18 **Printed Date:**2013-05-18 **SOIL TEST REPORT** **Page:**1

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	Buffer	CEC meq/100g	% K	% Mg	% Ca	% H	% Na
1	26135	2.4	19 L	24 L	60 L	220 H	1590 H	19 M	7.3		10.0	1.5	18.3	79.5		0.8
2	26136	2.7	9 VL	16 VL	70 L	250 H	1480 M	21 M	6.4	6.9	10.9	1.6	19.1	67.7	10.7	0.8

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	Field ID
1								2 VL	690	0.1 G		0.08	36	
2								2 VL	901	0.4 G		0.08	39	

Soil testing is a valuable tool for ensuring that the productivity of the biomass crop is not hampered by the improper availability or balance of nutrients. Soil testing is essential on fields that have been fallow for several years. Soil tests usually cost less than fifteen dollars per sample.

Seed and Seeding Rate

Switchgrass

Switchgrass is being successfully seeded in Ontario at a rate of 6-8 pounds per acre. Seeding rates are in pounds of Pure Live Seed (PLS) per acre. Ensure that purchased seed has been tested and has a PLS rating. The amount of seed required per acre must be adjusted so that desired amount is applied. PLS ratings do vary by variety so when seeding several varieties appropriate planter adjustments must be made. Soil type and seedbed conditions may also affect seeding rates. Boosting seeding rates may be needed when planting in less-than-ideal soil types and field conditions.

Switchgrass should be planted after the soil warms to between 10 degrees C to 18 degrees C. Conventional or no-till drills can be used but the drill should have packing wheels. Switchgrass should be planted at shallow depths: ¼ to ½ inch (6.4 mm-12.7 mm) in fine soils, or ¾ inch (19 mm) in coarse soils. Some US studies across multiple locations suggest that stand establishment and seedling vigor can be improved by planting at deeper depths of ½ to ¾ inch (12.7-19 mm) in fine soils, or up to 1 inch (25 mm) in coarse soils.

Buying Seed by the Pure Live Seed (PLS) Standard

Native grass seed inherently includes more nonviable seeds and inert matter (such as chaff, weed seeds and seed hulls) than, for example, corn seed which is relatively easy to condition and bag. As a result, planting rates are based on the calculation of Pure Live Seed (PLS).

% Germination + % Dormant = % Viable

% Viable x % Purity = PLS %

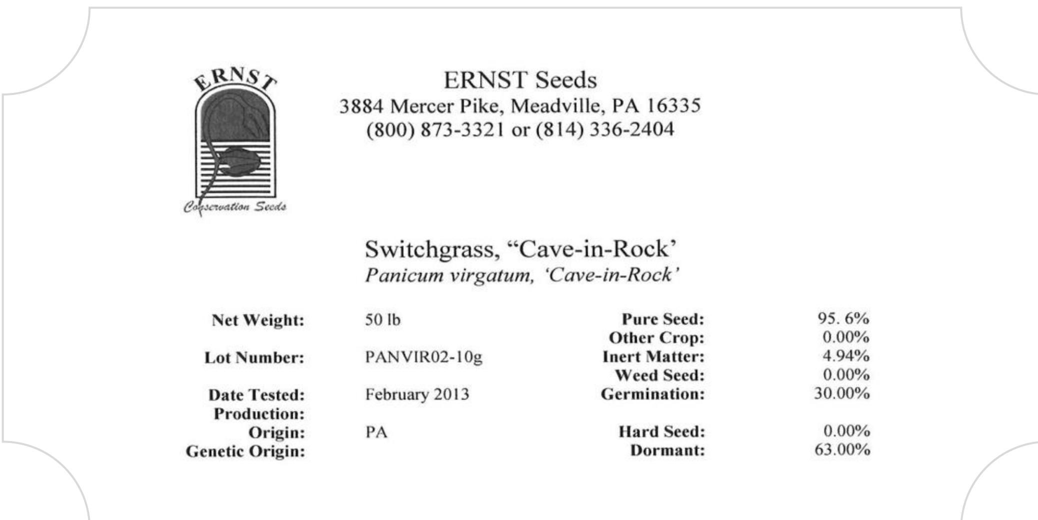
Example

80 % Germination + 6 % Dormant = 86 % Viable

86 % Viable x 98 % Purity = 84 % PLS

In quality seed stocks, purity is typically 98 per cent or better. Viable seeds include both those that are dormant (hard seed) and non-dormant. Since the viable seed percentage used to calculate PLS percentage includes dormant seeds, a high PLS percentage does not necessarily mean high germination percentage; PLS and germination are separate indicators of the seed quality. Care should be taken when reading the seed tag.

The tag below is from the Kanlow Switchgrass variety used in the field trials. Purity is excellent at 95.6 per cent. In this sample, the germinated seed is 30 per cent and the dormant seed percentage is 63.



Given the formula above, this seed lot has PLS as follows:

30% germination plus 63 per cent dormant = 93 per cent viable
93% viable x 95.6 % purity = 88.91 Pure Live Seed (PLS)
To ensure 8 pounds of PLS per acre you will need to plant (8.0/88.91) x 100= 8.99 pounds per acre.

Rapid and uniform germination is important to successfully and cost-effectively establish switchgrass stands. Many native perennial grasses, like switchgrass, often have a high proportion of dormant seed, up to 95 percent, immediately after harvest. This dormancy is temporary. The seed tag above indicates a seed dormancy of 63 per cent which means that a delay in germination may occur until dormancy is overcome by soil temperature and soil moisture variations.

Use of a Nurse Crop with Switchgrass

The grower also has the option of using a nurse crop such as oats or spring wheat during the year of establishment. A nurse crop is an annual crop used to assist in establishment of a perennial crop. The widest use of nurse crops is in the establishment of legumes such as alfalfa, clover and trefoil. Occasionally nurse crops are used for establishment of perennial grasses.

Nurse crops reduce the incidence of weeds, prevent erosion, keep soil moist and prevent excessive sunlight from reaching tender seedlings. Often the nurse crop can be harvested for grain, straw, hay, or pasture. Oats are the most common nurse crop, though other annual grains are also used. This co-seeding strategy provides opportunity for some income in the year of establishment. The nurse crop should be removed so that new seedlings are not shaded for the entire establishment-year growing season.

Ontario growers' opinions on use of a nurse crop with switch grass establishment vary widely. A few have experienced good success by using spring wheat as a nurse crop. Others have moved away from this practice. Spring wheat is a less attractive option in areas with heat unit ratings above 3000 HU per year. In these areas spring wheat yields often drop below profitable levels. Growers in these areas have had best seeding success by adapting direct seeding methods similar to establishing a direct seeded hay crop. Both the Six Nations and the Walpole sites have heat unit ratings near or above 3000 HU so the crops were direct seeded without a nurse crop.

Seeding Miscanthus

Current miscanthus genotypes are sterile hybrids producing no seeds. Miscanthus is established using rhizomes or plugs that have been harvested from established plants. Growers have the option of purchasing different sized rhizomes. Generally the larger the rhizome, the better the emergence will be. When seeding smaller rhizomes the seeding rate of rhizomes per acre is increased.

The shelf life of the rhizome decreases as the size of the rhizome decreases. The time between digging of the seed stock and the planting date must be kept a short as possible when seeding smaller one node root stock or plugs as they are often called. This window between digging and planting should be no longer than three weeks. Growers need to ensure that newly dug rhizomes are kept cool and moist. A deterioration of rhizome quality will result in poor emergence and an imperfect stand. Seeding usually requires the use of a modified planter. In options one and two, roots are manually fed into the planter shoe of single or multiple row planters. In option three, there are two row planters that feed automatically and distribute the rhizomes along the row in a one foot wide band.

Examples of miscanthus rhizome size and seeding rates are:

Option 1: Largest Size: Rhizome root chunks of 3x3x3 come from a mature plant crown, sectioned into small square chunks with fine root hairs and soil remaining intact. Expected emergence rate and established plant stand is nearly 100% as there are 2 – 4 rhizomes per chunk with 10+ active nodes per chunk. Crop is quick to emerge even in dry conditions. The approximate root stock cost is $.80 per unit. Cost per acre will be $4000 when root stock is seeded at a density of 5000 per acre and planted three feet apart in three foot row spacings.

Option 2: Intermediate Size: Intermediate seed stock contains rhizomes that are 3” to 5” in length and .5” diameter. There are several active nodes per rhizome. Each rhizome averages 40-50 grams in size. The approximate cost is $.35 each. At the recommended planting density of 5000 plants, seed cost per acre cost is $1750. Expected emergence is 85-95 %. Row spacing remains the same as option I.

Option 3: Smallest Size: Rhizomes are 10 to 35 grams; small 1.5” to 3” in length, .25 to .5” diameter with a single active node per rhizome. Planting density is increased to 10,000 to 15,000 per acre but emergence of only 50 per cent can be expected. These rhizomes cost 10 cents each with a resultant per acre seed cost of $1000 to $1500 per acre.

The cost of seeding miscanthus has decreased substantially as more growers have experimented and developed specialized equipment to streamline the process. Cost of establishment of miscanthus, while decreasing, remains above the cost of switchgrass and other small seeded species where a drill can be used.

Seeding Tall Grass Prairie

Seeding Tall Grass Prairies is more complex. Because there are over 40 TGP species in Ontario, various mixtures and blends are possible. Seeding rates of these mixtures are just as variable and will depend on the blend, location and proposed purpose of TGP once established. TGP seed cost can be significant. Some seed is hand collected from wild native stands. Other seed types come from small-established nurseries. Labour-intensive seed collection processes increase seed costs. Purifying and handling of small sample lots of tiny seeds is costly. Content of TGP mixtures and their seeding is mostly in the hands of those knowledgeable of TGP species and habit. Specialized seeding services may be contracted to oversee the seeding process.

Six Nations Rate: Seeding rate of Switchgrass used for this field was 10 pounds per acre.

Walpole Island Seeding Rates: Miscanthus seeding rate ranged from 4850 to 5000 plants per acre. The majority of the site was seeded at a density of 3 feet by 3 feet. A small area was seeded at 2 feet by 2 feet. Switchgrass was seeded at 12 pounds per acre. TGP seeding rate was 18 pounds per acre of a blend of seven grasses - Indian Grass, Big Blue Stem, Switchgrass, Virginia Wild Rye, Canada Wild Rye, River Bank Wild Rye, and Sporobolus or Tall Dropseed.

Test Plot Planting Summary			
	Rate (per acre)	**Spacing**	**Seed Cost** (per acre)
Miscanthus	500 rhizomes	3' x 3'	$1,540
Switchgrass	10-12 pounds	7" rows	$100
Tall Grass Prairie	18 pounds	broadcast	$282

Planting

Seeding methods of small seeded biomass grasses varies widely. Many rely on specialized seeders such as the Brillion seeder. These units provide the required seed placement adjustments, seeding rate calibrations and seedbed firming equipment to assist with proper stand establishment. Drills and no till drills with special grass seed attachments are used. Care has to be taken to keep seed near the soil surface with minimal soil cover.

The establishment phase of purpose-grown biomass grass crop requires attention to detail and an experienced hand. Since the biomass crop is expected to remain productive for many years, the established stand must be optimum. Cost of establishment needs to be spread over as many years as possible for the crop to be profitable.

Six Nations Experience

Barry Hill contracted a custom operator and equipment from the Alternative Land Use Services (ALUS) Project in Norfolk County. The ALUS group owns a ten foot wide Truax drill that handles small seed metering and placement very well. The Truax planting unit has double disc seed openers equipped with depth bands on each disc to ensure shallow seed placement. The unit also has discs out front of the seed openers making it possible to be used in minimum or no till situations. Packing wheels run behind each seed opener to firm the seed bed. The Truax unit performed very well at this location where the soil type varied from sandy loam to Haldimand clay. Soil conditions at the time of seeding were ideal to dry. Two varieties of switchgrass were seeded. These were Cave in Rock and Kanlow. The field was sectioned according to soil type, drainage and topographical features and seeded as pictured below.

Walpole Planting Experience

Miscanthus was planted over several days beginning the first week of June. A Walpole business called The North Eastern Seed Company provided the miscanthus root and the tall grass prairie mixture. The switchgrass was purchased from a US supplier. Owner Eric Fields supervised and completed the seeding of all varieties. Miscanthus rhizomes were placed into 3 inch holes that were dug using a hoe. Roots were individually placed and covered with soil by hand. A portion of the miscanthus was seeded in two by two foot spacing. Planting of the switchgrass and the TGP was completed much later than planned. A hand operated seeder was used for the switchgrass and the TGP. Seeding was interrupted on several occasions by wet weather. The area received over 120 mm of rain between July 1 and July 15. The Walpole Island seeding experience was not a normal occurrence. Seeding operations were completed by July 26.

Summary of plants seeded at Walpole Island:

Miscanthus
Kanlow Switchgrass
Tall Grass Prairie: Indian Grass, Big Blue Stem, Switch grass, Virginia Wild Rye, Canada Wild Rye, River Bank Wild Rye, and Sporobolus Tall Dropseed.

Monitoring Establishment Year

Germination, weed pressures and resultant stands need to be monitored during year 1. Emergence can be delayed under dry conditions but will usually recover later in the growing season when adequate moisture is received. The stand must be adequate to successfully compete with the growth of unwanted grasses and broadleaf weeds. Usually the competitive nature of a biomass stand will predominate over competitive weeds by year two. Currently there are no label recommendations for application of herbicides to control weeds on emerged stands. Growers have been experimenting on their own with herbicide applications to control of weed infestations. Herbicide trials are underway in Ontario.

Weed pressure will be evident in the establishment year. Excessive competition from grassy weeds such as crabgrass and nutsedge can lead to seeding failures. In the absence of thoroughly tested and labeled herbicides, mechanical forms of weed control can be an effective alternative. When mowing to control weeds, take care to avoid clipping off the leaves of the switchgrass seedlings, and especially avoid cutting below the growing point. Mow weeds to the height of the switchgrass seedlings as often as necessary during the establishment year.

Note: The presence of weeds at the end of the first year is not necessarily an indicator of stand failure. As long as a suitable number of viable seedlings are present at the end of season one, the stand can still become densely populated in the following year.

Six Nations Establishment

The Six Nations site received over 50 mm of rain the day following seeding. Unusually wet conditions continued for 10 days. In field erosion buried some seed beyond the desired depth and in those areas emergence was delayed.

June 17 - First seedlings were about 2.5 cm in height. No weed pressure was evident. Seedling emergence was delayed on clay hills and low wet areas.

July 16 - Weeds were cut to the height of the switchgrass. Some plants now over 12inches high

July 29 - Clay area of field shows need of rain and the presence of significant weed pressure. A few smaller switchgrass plants are evident under the weed canopy.

Walpole Establishment

June 10, 2013: Spring tillage produced an ideal level, firm seed bed. Weed pressure was not a factor when seeding began. On this date wet soil conditions were evident but miscanthus seeding continued.

August 1, 2013: Seeding of all varieties was complete. Only the miscanthus had emerged. The accompanying photo shows developing miscanthus at heights over 12 inches or 25 cm. Although emerged plants were healthy, only 50 per cent of the rhizomes had produced top growth. A fifty per cent stand is cause for concern. Non emerged roots were uncovered and found to be inert with no active nodes. Rhizomes were difficult to find in other locations and may have decayed altogether. The supplier of the root stock was to be contacted for their evaluation. The miscanthus acreage will require filling in of the missing plants at a later time if the stand remains at 50 per cent.

August 1, 2013:

Weed pressure was evident in the miscanthus acreage. A flush of poplar seedlings had emerged to a height of 6-8 inches. This was monitored closely. Clipping of the taller broadleaf weeds may be required. The miscanthus area will not be clipped so the growing point remains intact. To avoid herbicide seedling injury, application was delayed until 2014.

Production Years

Weed Control

A purpose-grown biomass stand reaches full maturity by year three. The crop will canopy early and naturally dominate unwanted weeds and grasses. Achievement of a weed free biomass stand hinges on maintaining a dense and productive plant stand. Gaps resulting from poor establishment or winter kill will give weeds a chance to move in.

Insects and Diseases

Currently no insects are recognized as major threats. Some rusts and viruses have been observed in mature stands but have not significantly reduced productivity. These observations may change as purpose-grown biomass acreages expand to cover a wider area and are grown under more diverse cropping situations.

Fertilizer Requirements

A one-cut harvest after senescence allows maximum nutrient recycling and minimizes the amount of added fertilizer required. Over fertilization with nitrogen usually results in crop lodging, which ultimately results in yield reduction and harvesting difficulties. Usually no phosphorus or potassium is applied on medium to rich soils under biomass cultivation. Both test sites will require potash-phosphate application in year two as indicated in the soil tests. Soil concentrations of these two nutrients should be monitored every 2-3 years after establishment and fertilization performed if deemed necessary through the results of a soil test.

Harvesting

Miscanthus, switchgrass and TGP are purpose-grown biomass crops that are best grown as a one-cut per year crop, with the harvest performed any time after fall dormancy is well initiated (i.e. leaf yellowing). This allows crop senescence and nutrient and carbohydrate translocation to the root reserves to help encourage winter survival. It is common practice to cut and row the crop in the late fall pre winter time frame. Ideally harvest occurs in mid-winter (in snow-free conditions) or early spring (anytime between mid-April and late-May). If fall cutting, it is best to leave at least a 10 cm stubble to improve winter survival and reduce winter heaving.

TGP may be an exception because some TGP species are susceptible to significant lodging field loses. These losses result from lodging if left uncut or from deterioration if left in the swath. Another common problem on heavier soils is that field conditions are too wet in the fall to enable baling and removing bales from the field. Rutting and compaction will negatively affect future production.

Delaying the harvest to the following spring has the advantage of improving winter survival and weed control. It also reduces nutrient extraction resulting in reduced fertilizer requirements and improves combustion properties of the material. The ash content of the biomass typically declines from fall to spring. By spring the crop is typically harvested at 12-14% moisture as good drying conditions are present and the crop senesce has maxed out. Harvesting a dry product eliminates the need for drying and deterioration during storage is not significant.

The main problem that has been identified with overwintering standing biomass in fields has been breakage and lodging from winter winds and ice storms. As much as 20-30% of the total dry matter can be lost in fields. Further losses can occur from cutting the material in the spring when crop is brittle and shatters easily. In these conditions use of a swather is preferred over the use of a mower conditioner. Well-drained sandy soils offer the greatest flexibility for farmers in accessing fields under wet weather. Undrained clay soils will undoubtedly pose harvest challenges in some production years.

The method of harvest of purpose-grown biomass grasses is largely determined by the end user or marketplace. The product is baled in field in large square bales or large round bales. Balers can also be equipped with chopping knives to create a denser bale of chopped biomass. Bales are removed from the field, stored on farm and can be transported with relative ease. This process is the most cost efficient. Another process is to chop the product in field using a forage harvester. The product would be blown in to a harvester wagon or dump truck. The chopped product is bulkier, more difficult to store and more costly to transport to an end user. Usually a chopped product would require on farm compaction or densification prior to off farm transport. The process used on the farm will be determined by the end user's preferred form of raw product.

HARVEST PROCESS USING A ROUND BALER

Mature stand of switchgrass

Swathing

Overwintering in the swath

Spring baling

Net wrapped and ready for transport

Field after harvest

Yield Benchmarks

Yield potential is increasing. Grower experience has improved and higher yielding varieties are becoming available. Purpose grown biomass grass crop yields vary widely. Maximum yield is not achieved until year three. Miscanthus has by far the highest dry matter yield potential per acre with switchgrass second and TGP third.

Yield benchmarks for this discussion were adopted from the report entitled: Assessment of Business Case for Purpose-Grown Biomass as this was a report for the Ontario industry. These yields are listed in the chart below:

YIELD-TONNES PER ACRE					
CROP	**PRODUCTION YEAR**				
	ONE	**TWO**		**THREE**	**FOUR**
SWITCHGRASS	0	1		4.3	4.3
MISCANTHUS	0	3		7.5	7.5
TALL GRASS PRAIRIE	0	1		4	4

Economics and Marketing

Establishment-Year Costs

Cost of Production has been split into two segments- costs of establishment, and costs in the production years. Custom rates were determined from the OMAF publication: Survey of Ontario Custom Farm Rates- 2012. Miscanthus establishment costs include equipment rental and labor. All cash flow models include the cost of harvest activities at Ontario custom rates as well. These activities include swathing, baling and moving from field to an on farm storage or to a site for plastic covering.

The major variable in establishing purpose-grown biomass grass crops arises from seed and/or root source. Since miscanthus is established from rhizomes the cost of establishment can be much higher. Recent research has shown that Miscanthus planting costs can be reduced by utilizing specially prepared rhizome plugs and specifically designed planters. Some in the industry claim that cost of root and planting can be reduced to $400 per acre. The cost for this model represents the use medium sized rhizomes seeded by hand. This method of seeding led to a very high cost of establishment. Seed costs used for switchgrass and TGP are the actual costs experienced with the field study. There is significant cost of establishment differences between the three genotypes. The cost comparison is not meant to discourage miscanthus production but instead demonstrate the need to use all means available to lower establishment costs.

Establishment Year Only

	Crop		
	Miscanthus	Switchgrass	Tall Grass Prairie
fall			
spraying	$ 10.00	$ 10.00	$ 10.00
herbicide (2l glyphosate)	$ 20.00	$ 20.00	$ 20.00
spring			
herbicide	$ 25.00	$ 25.00	$ 25.00
application	$ 10.00	$ 10.00	$ 10.00
starter fertilizer	$ -	$ -	$ -
seed/root	$ 1,540.00	$ 100.00	$ 282.00
Equipment rental/labor	$ 625.00	$ 50.00	$ 50.00
Field Operations- tillage-2 passes	$ 40.00	$ 40.00	$ 40.00
packing	$ 15.00	$ 15.00	$ 15.00
clipping twice	$ 40.00	$ 40.00	$ 40.00
Land rent	$ 30.00	$ 30.00	$ 30.00
Interest-operating	$ 117.75	$ 17.00	$ 26.10
Total establishment Cost	$ 2,472.75	$ 357.00	$ 548.10

Assumptions

- *no fertilzer in establishment year*
- *herbicide application - fall and spring*
- *Field work assumes-- 2x field cultivator passes*
  - *one cultipacker pass*
  - *planter - rental*
  - *clipping- twice*
- *field activity cost based on local custom rates*
- *interest cost- 5 per cent interest rate*
- *seed reflects actual cost*

Production Year Costs

Once established, maintaining yield and productivity over several years requires minimal crop inputs. The yearly production budget below maintains a small fertilizer input cost as well as land rent. The remainder of the costs are directly associated with harvesting and storing on farm.

Production Years

	miscanthus		switchgrass		tall grass prairie	
	2nd year	3rd year	2nd year	3rd year	2nd year	3rd year
projected yield-tonne/acre	3	7.5	1	4.3	1	4
Large square bales per acre	8.6	21.4	2.9	12.3	2.9	11.4
Fertilizer	$ 30.00	$ 50.00	$ 30.00	$ 50.00	$ -	$ -
Herbicides	$ -	$ -	$ -	$ -	$ -	$ -
custom work						
swathing/acre	$ 17.00	$ 17.00	$ 17.00	$ 17.00	$ 17.00	$ 17.00
baling	$ 68.80	$171.20	$ 23.20	$ 98.40	$ 23.20	$ 91.20
field to storage	$ 34.40	$ 85.60	$ 11.60	$ 49.20	$ 11.60	$ 45.60
storage	$ 30.00	$ 75.00	$ 10.00	$ 43.00	$ 10.00	$ 40.00
land	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00
other	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00
Total Cost	$ 220.20	$ 438.80	$ 131.80	$ 297.60	$ 101.80	$ 233.80

Assumptions

- *Custom work for all harvest*
  - *swathing 17 per acre*
  - *baling -lg sq. 8 per bale*
  - *field-storage 4 per bale*
  - *storage 10/tonne*
- *large square bale wei 350 kg*

Cost of Production

Ontario agronomic biomass research has progressed rapidly. Proven planting and harvesting systems, variety improvement, and herbicide availability continue to dramatically lower cost of establishment and cost of production. Cost of production estimates from previous studies vary from $70-$90 per tonne. If the cost of establishment is spread over 15 years and added to the yearly costs, the cost of production per tonne for miscanthus in this trial $80.48 per tonne and $74.79 per tonne for switchgrass. It should be noted that the suggested land cost in this model $30 per year. Ontario average yields have been used.

Raw Product Price: Under the assumptions used in this model, the cost of producing one tonne of biomass ranges from $70 to $80 per tonne. Farmers will require a farm gate price above $100 per tonne in order that margins are adequate to recover establishment cost and to provide a profit over the long term.

Analyzing Cash Flow and Investment Recovery

The cost of establishment of a purpose-grown biomass crop is very significant and requires careful consideration especially when production and yearly gross income are not maximized until the third year. The rate of recovery of cash invested for establishment depends on the market price which must be sufficient to produce a positive yearly cash flow as quickly as possible. The example below shows the years required to recover establishment cost and to return to a positive cash flow for both miscanthus and switchgrass with an assumed market price of $100 per tonne FOB the farm gate. The cost of miscanthus establishment at Walpole Island was used. The crop establishment recovery cost period for the miscanthus is unacceptable; taking ten years to fully recover the initial investment. This emphasizes the need to keep cost of establishment as low as possible. In contrast, the switchgrass model which represents the Six Nations experience shows a cash investment recovery period of five years which is more acceptable. Cost of establishment is the only major difference between the miscanthus and the switchgrass cash flow analysis models.

Miscanthus			
Cash Flow analysis by year			
Year	Cumulative Cost †	Projected Income *	Cash Position
1	$ 2,472.75	$ -	$ (2,472.75)
2	$ 2,692.75	$ 300.00	$ (2,392.75)
3	$ 3,131.50	$ 1,050.00	$ (2,081.50)
4	$ 3,570.30	$ 1,800.00	$ (1,770.30)
5	$ 4,009.10	$ 2,550.00	$ (1,459.10)
6	$ 4,447.90	$ 3,300.00	$ (1,147.90)
7	$ 4,886.70	$ 4,050.00	$ (836.70)
8	$ 5,325.50	$ 4,800.00	$ (525.50)
9	$ 5,764.30	$ 5,550.00	$ (214.30)
10	$ 6,203.10	$ 6,300.00	$ 96.90

Switchgrass			
Cash Flow analysis by year			
Year	Cumulative Cost †	Projected Income *	Cash Position
1	$ 357.00	$ -	$ (357.00)
2	$ 488.80	$ 100.00	$ (388.80)
3	$ 786.40	$ 530.00	$ (256.40)
4	$ 1,084.00	$ 960.00	$ (124.00)
5	$ 1,381.60	$ 1,390.00	$ 8.40
6	$ 1,679.60	$ 1,820.00	$ 140.40
7	$ 1,976.80	$ 2,250.00	$ 273.20
8	$ 2,274.40	$ 2,680.00	$ 405.60
9	$ 2,572.00	$ 3,120.00	$ 548.00
10	$ 2,869.60	$ 3,550.00	$ 680.40

† Cumulative Cost = Establishment cost + Yearly cost

* based on raw product price of $100 per tonne

Additional On Farm Costs

Future major biomass markets will require that on farm biomass production meets certain requirements such as moisture, ash content and density. Drying on farm enables storage of the crop with no deterioration in quality but this becomes an added cost. Special heavy duty large square balers can densify the crop and help lower the costs of transportation. Harvesting equipment is very costly leading small biomass producers to use local custom operators to perform these processes.

Currently, biomass producers face tough decisions regarding investing in equipment that will add value and broaden market opportunities for biomass products. The decision to process or not to process on farm becomes very clouded as end users want the product in different forms and with different specifications. To date on farm pelletizing technologies are available but can be inefficient and costly to purchase and maintain. Biomass producers could be enticed to invest in processes that add value to their product with properly priced long term orders from end users. Industry is not prepared to make that commitment at this time.

Market Opportunities

Local Agricultural Markets

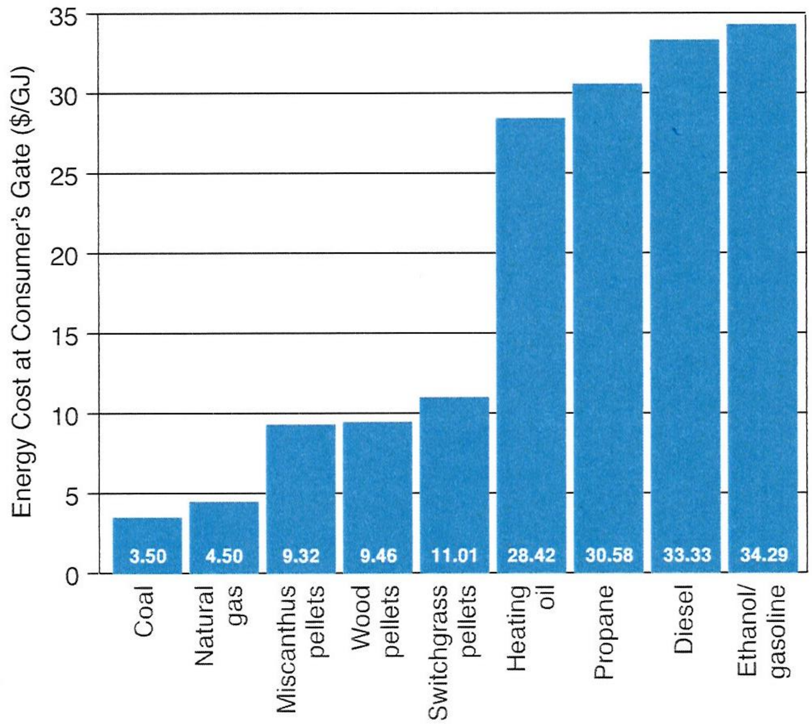
Purpose-grown biomass grasses may be used in livestock rations, as a bedding substitute for straw or as a straw substitute in other market applications. Use as feedstock would require an earlier harvest in most instances. Biomass grasses can be used in mulch situations or as compost for mushroom production for example. Mushroom growers prefer biomass grasses in their compost because the product decomposes more slowly than straw which prolongs the life of the compost. Biomass products must be price competitive with straw to capture these markets. Many of these markets are small, regional, and seasonal. On the positive side, no on farm processing would be required. Market price would reflect cost of trucking and length of time on farm storage is required. The First Nations producers would have to research local markets in their area before committing to significant on farm biomass production.

Heat/Green Energy Source Markets

Purpose-grown biomass products such as grass biofuel pellets have the potential to replace other forms of heat/energy sources. One general fact in favor of the use of biofuel pellets is that the pellets when burned using close-coupled gasification technology have comparable conversion efficiencies as oil furnaces. Greenhouse gas emissions are greatly reduced and the carbon dioxide foot print is less. Also, biomass being a low grade heat source is in most cases replacing high grade forms of energy such as oil and natural gas leaving these energy forms for other applications.

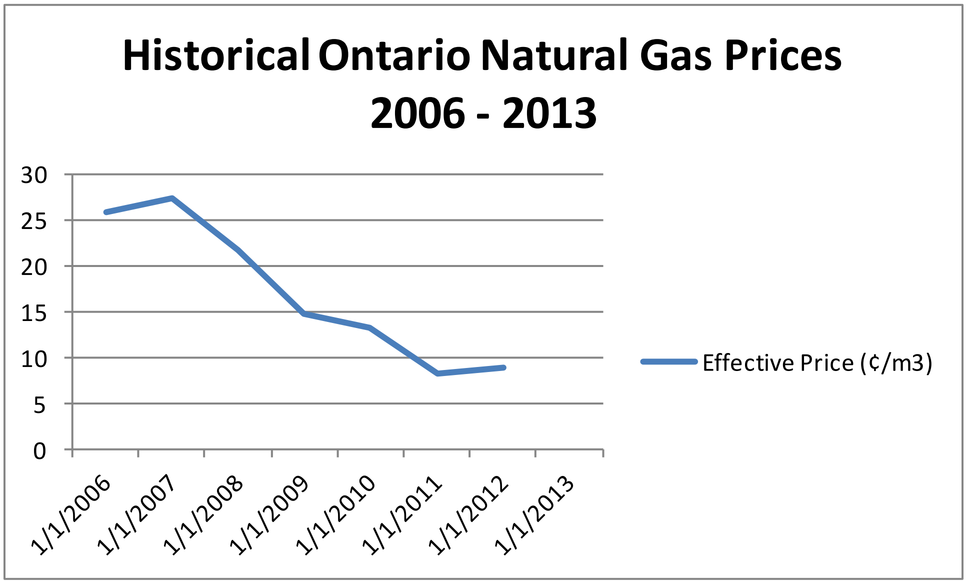
The following graph compares the cost of miscanthus and switchgrass pellets to various sources of energy in Ontario. An end user price of $172.45 is assumed for miscanthus and $203.75 for switchgrass. The graph below shows the wide range in costs of energy sources in Ontario. The graph demonstrates that purpose-grown biomass pellets are not likely to have any economic advantage at current prices where coal and natural gas are available. Woods pellets are very competitive with purpose-grown biomass pellets. At this time heat/energy market potential biomass grass based pellets exists mostly in areas where oil is the heat source and natural gas is not available. In these areas wood pellets and grass pellets can be economical sources of heat energy.

Excerpt from "Biomass in a Combustion Market" by OFA



The Natural Gas Connection

Discussions about current lack of market development for purpose-grown biomass often end up with a comment about the abundance of cheap natural gas in Ontario. The chart below makes it very evident why this is so. The price drop of natural gas since 2006 has been nothing short of remarkable. Current natural gas prices lessen the economic incentive for a natural gas consumer to switch to a biomass grass product as a heat/green energy source. Energy prices can change significantly in a short time however. A return to the natural gas prices of 2006 would certainly increase interest in purpose-grown biomass grass.



Ontario Greenhouse Market

A study released by REAP-Canada (Resource Efficient Agricultural Production) provides interesting data on the Ontario Greenhouse industry. The current greenhouse area in Ontario is estimated at 2610 acres. The study calculates that 562,000 tonnes of biomass would be required to satisfy the heat demands of the current area under glass in just Ontario.

The majority of greenhouses in Ontario are heated with natural gas. As stated above natural gas is the most cost effective heat source for the industry at this time. Those greenhouse businesses with access to natural gas have no economic incentive to change to another heat source. Biomass pellets as a heat source have significant potential for businesses in other areas such as Northern Ontario where cheaper forms of heat energy may not exist. Factors to consider when switching to a biomass product as heat source are discussed later.

Ontario Power Generation

Most purpose-grown biomass interest and research was been spawned as OPG began the process of eliminating the use of coal in the generation of hydroelectricity. OPG showed interest in the replacement of coal with the burning of purpose-grown biomass as the heat source in these plants. Interest has been tempered by the present low cost of natural gas and the abundant availability of other electricity sources such as nuclear. At this time OPG has not rejected the possibility of using biomass fuel pellets but the power giant is more likely to convert former coal plants to use natural gas when and if

Ontario requires additional electrical power.

Retail and Residential Heating Fuel Market

There are many considerations beyond economics when converting to biomass pellets as a heat source heat for your home or business. The capital outlay required can be significant. Furnaces that are specially designed and approved for the use of biomass pellets are required. These units have closed coupled gasification technology that removes the problem of high emissions and reduces ash build up. Other factors that can influence customer satisfaction are pellet dustiness, pellet handling, space for pellet storage, appliance maintenance and cleaning, variable pellet quality and the sound of appliance fan and augers.

Do switchgrass pellets work in all wood pellet stoves?

Switchgrass pellets do not burn the same as premium wood pellets. They contain a higher ash percentage that acts differently than wood ash. Through research by a number of universities and pellet appliance manufacturers, there have been a number of stoves identified that are capable of handling switchgrass pellets. Consumers should contact their stove manufacturer to determine the capabilities of their stove or furnace. Mass consumer conversion to a biomass pellet based heating systems appears unlikely until very significant cost savings can be realized. No one can determine the timeline for such an occurrence.

Export Market

Wood pellets are used for heat in many European countries. This is at present a complex market to be developed and serviced by experienced exporters. As wood sources for the manufacture of pellets wanes then the interest in biomass grass fuel pellets will develop.

Other Market Opportunities

The search for new market opportunities is never ending. Companies are experimenting with new processes that would efficiently utilize purpose-grown biomass grasses for the production of cellulosic ethanol. Production of cellulosic ethanol has not progressed because of economic retracing due to the 2008 recession.

While these processes are past the prototype stage, it remains uncertain if the conversion process is such that the farmer can be paid above a breakeven price for the crop. Ontario biomass producers are working with processors and manufacturers on a variety of products. Biomass markets currently under investigation include: use as an ingredient in plastics, and car interiors like dashboards, or to replace wood chips to produce high pressure fiber board. A dramatic increase in the price of fossil fuels would stimulate the development of new products such as these.

The Chicken and the Egg Dilemma

The industry is currently hampered by the chicken and the egg syndrome: what comes first. End users want assurance that there will be sufficient biomass raw product to support new manufacturing processes. They want production guarantees in terms of acres and tonnes of product before huge investments of capital are made to adapt processes for the use of biomass. Farmers are saying show us the money and we will grow biomass for you. The market must be long term and provide a reasonable return to the farmer. Frustration is evident among the pioneers of the biomass industry in Ontario due to the lack of significant market development. Pelletizing mill costs are prohibitive in most cases until a sustainable marketing opportunity emerges. Local niche market opportunities may be profitable for only a few producers. Ontario farmers are poised to produce biomass but as yet the market is not of sufficient size to stimulate further growth.

General Conclusions

The analysis of the purpose-grown biomass grass industry for First Nations concludes the following:

- First Nations communities in Ontario have significant acreage available for purpose-grown biomass production. On average, land cost is below the Ontario average and would enhance First Nation's ability to produce a lower cost product.
- The First Nations farm sector would benefit enormously from growing this perennial grass crop in their rotations. The crop would complement the predominant soybean and winter wheat rotation. Soil organic matter, natural drainage capacity and soil tilth would be enhanced with little draw down of fertility.
- First Nations producers must strive for average yields and low costs of establishment to achieve a price advantage as an Ontario purpose-grown biomass market develops.
- The two trial sites now underway should be maintained and the results monitored over the longer term. The results will formulate an important template for success for future First Nations purpose-grown biomass producers. Information transfer in the form of field trials is invaluable to the sector. Further, it is hoped that results from the trial sites can be added to this report.
- At the time of writing, the economics required to promote the development of on farm purpose-grown biomass production are not in place. The market has not developed as quickly as originally envisioned. Significant agronomic progress has been achieved in all areas of production. Markets that create demand for purpose-grown biomass FOB the farm are required to propel the industry beyond its present experimental mode.

Appendices

Appendix A

BIOMASS FIELD TRIAL STEERING COMMITTEE										
Title	**First Name**	**Last Name**	**Occupation**	**Company Name**	**Address Line 1**	**Address Line 2**	**City**	**State**	**ZIP Code**	**E-mail Address**
Mr.	David	Armitage	Manager, Research Department	Ontario Federation of Agriculture	100 Stone Road West	Suite 206	Guelph	Ontario	N1G 5L3	david.armitage.ofa.on.ca
Mr.	Scott	Banks	Emerging Crop Specialist	OMAFRA	1 Stone Road West		Guelph	Ontario	N1G 4Y2	scott.banks@ontario.ca
Mr.	Nick	Betts	Outreach Coordinator	Ontario Soil and Crop Improvement Association	1 Stone Road West		Guelph	Ontario	N1G 4Y2	nick.betts@ontariosoilcrop.org
Mr.	Bill	Deen	Plant Agriculture	University of Guelph	50 Stone Road East		Guelph	Ontario	N1G 2W1	bdeen@uoguelph.ca
Mr.	Grant	Edwards	Farm Management Advisor	Indian Agricultural Program of Ontario	6453 Hamlyn St.,	P.O. Box 83 Lambeth Station	London	Ontario	N6P 1P9	grant@indianag.on.ca
Ms.	Heather	Engbers	Research Assistant	Ontario Soil and Crop Improvement Assoc.	50 Stone Rd E		Guelph	Ontario	N1G 2W1	Heather.Engbers@ontariosoilcrop.org
Mr.	Jamie	Hall	General Manager	Indian Agricultural Program of Ontario	220 North St.,	P.O. Box 100	Stirling	Ontario	K0K 3E0	jamie@indianag.on.ca
Mr.	Barry	Hill	Farmer Co-operator		2080 4th Line	R.R. # 1	Ohsweken	Ontario	N0A 1M0	barryhill28@yahoo.ca
Mr.	Mel	Hoeksma	Manager	Tahgahoning Enterprises Inc.	Walpole Island	R.R. 3	Wallaceburg	Ontario	N8A 4K9	tei@hotmail.ca
Mr.	Graham	Hoogterp	Community Liason	Tahgahoning Enterprises Inc.	Walpole Island	R.R. 3	Wallaceburg	Ontario	N8A 4K9	grahamhoogterp@gmail.com
Mr.	Charles	Lalonde	Agri-Environmental Consulting	C J Agren Consulting	15-941 Gordon St.		Guelph	Ontario	N1G 4R9	charles.lalonde73@gmail.com

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