

TEACHER GUIDE GRADES: ||-|2



Acknowledgements

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Agriculture et Agri-Food Canada Agroalimentaire Canada



Teacher Notes

Introduction

Sustainability is a concern we all share. We know that our earth is a precious resource and it is our responsibility to use the resources provided by the earth in a sustainable way. This teacher resource was developed to help educate people about the ways in which Canada's farmers are working to provide resource sustainability for all Canadians. By using this teacher resource you will help students develop a better understanding of the types of products that agriculture has made available to reduce our reliance on materials and products that are not sustainable.

How to use the Resource

This course was written to support the secondary subjects of technological education-green industries/agriculture, environmental science, geography and science. There are a series of three lessons, which can be taught individually or be used as a co-operative learning organizer, using the jigsaw strategy.

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Expectations

Physical Geography: Patterns, Processes, and Interactions, Grade 11, University/College Preparation

 explain the importance of stewardship and sustainability as guiding principles for human use of the physical environment.

Biology, Grade 11, University preparation

F1. evaluate the importance of sustainable use of plants to Canadian society and other cultures.

Biology, Grade 11, College Preparation

F1. analyse the roles of plants in ecosystems, and assess the impact of human activities on the balance of plants within those ecosystems.

Chemistry, Grade 12, University Preparation

D1. analyse technologies and chemical processes that are based on energy changes, and evaluate them in terms of their efficiency and their effects on the environment.

Chemistry, Grade 12, College Preparation

F1. evaluate the importance of government regulations, scientific analyses, and individual actions in improving air and water quality, and

Just the Terms

In this activity students will develop an understanding of the basic terminology needed to understand how bioproducts are developed. This activity is designed for the whole class as an introduction to the topic.

All expectations provided are overall expectations

propose a personal plan of action to support these efforts.

Environmental Science, Grade 11, University/College Preparation

- F1. assess the impact on society and the environment of the use of various renewable and non-renewable energy sources, and propose a plan to reduce energy consumption;
- F2. investigate various methods of conserving energy and improving energy efficiency;
- F3. demonstrate an understanding of energy production, consumption, and conservation with respect to a variety of renewable and non-renewable sources.

Environmental Science, Grade 11, Workplace Preparation

- C2. investigate how different environmental factors can affect people's health and their lifestyle choices;
- D1. evaluate initiatives and technological innovations related to energy consumption and conservation, and assess their impact on personal lifestyles, social attitudes, and the environment;

- D2. investigate various methods of conserving energy and improving energy efficiency;
- D3. demonstrate an understanding of the basic principles of energy production, with reference to both renewable and non-renewable sources, and of various methods of energy conservation.
- E1. assess the environmental impact of the harvesting and/or extraction of resources, including ways of reducing this impact, and analyse threats to the sustainability of natural resources;
- E3. demonstrate an understanding of the sustainable use of resources and its relationship to the biodiversity and sustainability of ecosystems.

Science, Grade 12, University/College Preparation

F3. demonstrate an understanding of biological processes related to biotechnology and of applications of biotechnology in the health, agricultural, and environmental sectors.

Coming soon!

Curriculum expectations for Green Industries courses

Teaching and Learning Strategies

(Note: Access to internet ready computers is necessary for this activity)

- 1. Use one of the following ideas to introduce the unit on bioproducts:
 - a. Bring in a variety of bioproducts or pictures of bioproducts and have students play 20 questions in order to determine the relationship between the items
 - b. Show a clip from Agvision TV on a bioproduct see resource list for website address
 - c. Share a video or article regarding our dependence on fossil fuels and the need to move to a more sustainable source.
- **2.** Divide the class into small groups. Provide each group with a set of terms from the glossary included with this resource but do not provide them with the definitions.
- 3. Have each group search for the definitions of the terms and an example, using the websites suggested on the resource list.
- 4. Each group will present their definitions to the class, students will complete the worksheet "Terminology of Bioproducts".
- 5. Word walls can be created to support student literacy of the terminology throughout the unit.

Assessment and Evaluation

1. Definitions will be assessed for completion and accuracy prior to presentation to the class.

TERMINOLOGY OF BIOPRODUCTS

Term	Definition	Example



Expectations

Physical Geography: Patterns, Processes, and Interactions, Grade 11, University/College Preparation

- explain how the earth provides both a habitat for life and a resource for society;
- evaluate the impact of human life on the environment;
- explain the importance of stewardship and sustainability as guiding principles for human use of the physical environment.

Biology, Grade 11, University Preparation

F1. evaluate the importance of sustainable use of plants to Canadian society and other cultures.

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Chemistry, Grade 12, College Preparation

F1. evaluate the importance of government regulations, scientific analyses, and individual actions in improving air and water quality, and propose a personal plan of action to support these efforts.

Understanding the Facts

This activity is designed to help students understand how bioproducts can help reduce our dependency on non-renewable resources. The computer lab will need to be booked to allow groups access to the internet to research their topics. Allow at least one class period for research. This activity is designed as a jigsaw co-operative group activity. Note: If the teacher chooses, the activity can be teacher led using the information found on the websites listed.

All expectations provided are overall expectations

Environmental Science, Grade 11, University/College Preparation

- B1. analyse social and economic issues related to an environmental challenge, and how societal needs influence scientific endeavours related to the environment;
- B2. investigate a range of perspectives that have contributed to scientific knowledge about the environment, and how scientific knowledge and procedures are applied to address contemporary environmental problems;
- B3. demonstrate an understanding of major contemporary environmental challenges and how we acquire knowledge about them;
- D1. evaluate the impact of agricultural and forestry practices on human health, the economy, and the environment;
- E1. analyse economic, political, and environmental considerations affecting waste management strategies;
- F1. assess the impact on society and the environment of the use of various renewable and non-renewable energy sources, and propose a plan to reduce energy consumption;
- F2. investigate various methods of conserving energy and improving energy efficiency;
- F3. demonstrate an understanding of energy production, consumption, and conservation with respect to a variety of renewable and non-renewable sources.

Environmental Science, Grade 11, Workplace Preparation

C2. investigate how different environmental factors can affect people's health and their lifestyle choices;

- D1. evaluate initiatives and technological innovations related to energy consumption and conservation, and assess their impact on personal lifestyles, social attitudes, and the environment;
- D2. investigate various methods of conserving energy and improving energy efficiency;
- D3. demonstrate an understanding of the basic principles of energy production, with reference to both renewable and non-renewable sources, and of various methods of energy conservation.
- E1. assess the environmental impact of the harvesting and/or extraction of resources, including ways of reducing this impact, and analyse threats to the sustainability of natural resources;
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Science, Grade 12, University/College Preparation

F3. demonstrate an understanding of biological processes related to biotechnology and of applications of biotechnology in the health, agricultural, and environmental sectors.

Coming soon!

Curriculum expectations for Green Industries courses

Teaching and Learning Strategies

- 1. Teacher will introduce the co-operative learning project outlined on the worksheet entitled "Exploring Bioproducts".
- 2. Teacher will divide the class into small home groups, with 3 members per group. Each member within the group will be responsible for and become expert in one bioproducts topic:
 - a. Biofuels
 - b. Biogas
 - c. Household bioproducts
- **3.** Students will form into expert groups to research their specific topic using the references provided as well as other references they may find. Each expert group will complete an outline to share with their home group using the template provided. Allow work time in the computer lab for students to access the internet to find information on their topic.
- 4. In their expert groups, students will create a summary of their topic which they will share with their home group.
- **5.** Students will re-form in their home groups to share the information they learned in their expert groups. Each group member will record information on all 3 topics to be used in the final activity.

Assessment and Evaluation Strategies

1. Individual expert summaries will be marked according to the checklist provided.



EXPLORING BIOPRODUCTS

You have been assigned a category of bioproduct to explore. You will use the web-based resources to investigate your category. The websites listed at the end of this resource will provide you with a starting point for your research. As you complete your research, fill in the graphic organizer on the following page. Be prepared to share the information you have learned with your home group.

For your topic, (Biofuel or Biogas or Household Bioproduct), complete the organizer to show the following:

- The relationship between the original product and the products that can be made from it, as well as the product it replaces. E.g. Corn - ethanol and gas.
- how the bioproduct is produced
- two issues/challenges with producing this product
- environmental impact of the bioproduct

Criterion Referenced Checklist				
Criteria	Level 1 Limited	Level 2 Some	Level 3 Considerable	Level 4 High degree
Knowledge and Understanding Demonstrates an understanding of the terminology related to bioproducts				
Communication Expression and organization of ideas				
Application Use of critical/creative thinking processes, skills, and strategies				





Making the Connection

This activity is designed to help the students pull together all the information they have learned about bioproducts. Students will create a presentation for a specific audience. Students will be given a choice of presentation formats.

Expectations

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Environmental Science, Grade 11, University/College Preparation

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Environmental Science, Grade 11, Workplace Preparation

C2. investigate how different environmental factors can affect people's health and their lifestyle choices;

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- D2. investigate various methods of conserving energy and improving energy efficiency;
- D3. demonstrate an understanding of the basic principles of energy production, with reference to both renewable and non-renewable sources, and of various methods of energy conservation;
- E1. assess the environmental impact of the harvesting and/or extraction of resources, including ways of reducing this impact, and analyse threats to the sustainability of natural resources;
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Science, Grade 12, University/College Preparation

F3. demonstrate an understanding of biological processes related to biotechnology and of applications of biotechnology in the health, agricultural, and environmental sectors.

Coming soon!

Curriculum expectations for Green Industries courses

Teaching and Learning Strategies

- 1. Using the information gathered during Activity 2, students will create a presentation for a specific audience.
- **2.** The presentation can take the form of:
 - a. powerpoint presentation
 - b. lecture
 - c. news report
 - d. skit
 - e. song
- 3. Students will choose one of the following audiences:
 - a. A city/local council to explain how and why bioproducts can be useful in reducing the dependence on non renewable resources
 - b. The provincial government to explain to them why it is important to support the development of bioproducts
 - c. An investor to convince them to invest in bioproducts
 - d. A citizens group to explain the benefits and cautions associated with bioproducts
 - e. An elementary school class to show them the possibilities of bioproducts
- 4. Each student will be given 30 minutes to present their information and respond to questions from their audience.
- 5. The rest of the class will act as the audience as defined by the presenters.

Assessment and Evaluation

1. Presentations will be evaluated using the rubric provided.



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Criteria	Level 1	Level 2	Level 3	Level 4
Knowledge and understanding demonstrates knowledge and understanding of bioproducts	demonstrates knowledge and understanding of bioproducts with limited effectiveness	demonstrates knowledge and understanding of bioproducts with some effectiveness	demonstrates knowledge and understanding of bioproducts with considerable effectiveness	demonstrates knowledge and understanding of bioproducts with a high degree of effectiveness
Thinking use of initiating and planning skills	uses initiating and planning skills and strategies with limited effectiveness	uses initiating and planning skills and strategies with some effectiveness	uses initiating and planning skills and strategies with considerable effectiveness	uses initiating and planning skills and strategies with a high degree of effectiveness
use of processing skills and strategies	uses processing skills and strategies with limited effectiveness	uses processing skills and strategies with some effectiveness	uses processing skills and strategies with considerable effectiveness	uses processing skills and strategies with a high degree of effectiveness
Communication communication for different audiences and purposes	communicates for different audiences and purposes with limited effectiveness	communicates for different audiences and purposes with some effectiveness	communicates for different audiences and purposes with considerable effectiveness	communicates for different audiences and purposes with a high degree of effectiveness
Application making connections between science, technology, society, and the environment	makes connections between science, technology, society, and the environment with limited effectiveness	makes connections between science, technology, society, and the environment with some effectiveness	makes connections between science, technology, society, and the environment with considerable effectiveness	makes connections between science, technology, society, and the environment with a high degree of effectiveness
proposing courses of practical action to deal with problems relating to science, technology, society, and the environment	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

Glossary of Terms

Anaerobic Digestion - Decomposition process using micro-organisms that live and reproduce in an environment void of free or dissolved oxygen to decompose and stabilize organic solids or biosolids. This process generates biogases.

Biobased Economy - An economy in which most industry, commercial and economic activity depends on renewable biomass and biological processes to supply energy, chemicals, products and services.

Biobased Industries - Industries that rely on biological sciences in combination with engineering to produce a wide variety of industrial products from renewable organic resources.

Biodegradable - Capable of decomposing rapidly under natural conditions.

Biodiesel - Fuel made from plant oils that can be used in a conventional diesel engine.

Biodiversity - The relative abundance and variety of plant and animal species and ecosystems within particular habitats.

Bioenergy - Useful, renewable energy produced from organic matter.

Biofuels - Fuels made from cellulosic and other types of biomass resources. Biofuels include ethanol, biodiesel and methanol.

Biogas - A combustible gas derived from decomposing biological waste.

Biomass - Renewable organic matter. Biomass includes forest products, plants, agricultural crops and wastes, wood and wood wastes, animal wastes, aquatic plants, as well as organic fractions of municipal and industrial wastes.

Bioproducts - Commercial or industrial products that rely on energy, chemicals or processes available from living organisms. They replenish over and over again with the energy of the sun. They have the potential to reduce our dependency on fossil fuels.

Biotechnology - The application of biology and biological techniques to develop products and industrial processes.

Fossil Fuel Economy - An economy in which most industry, commercial and economic activity depends on fossil fuels and petrochemicals to supply energy, chemicals, products and services.

Resources to Support this Document

Agriculture and Agri-Food Canada - <u>www.agr.gc.ca</u>	Canadian Renewable Energy Network - <u>www.canren.gc.ca</u>
AgVision TV - <u>http://agvisiontv.farms.com</u>	Canadian Rural Revitalization Foundation -
BC Biotech - <u>www.lifesciencesbc.ca/bioproducts</u>	Constitution of the design of the second sec
BioAtlantech - <u>www.bioatlantech.nb.ca</u>	Council for Biotechnology Information - <u>www.wnybiotech.com</u>
BIOCAP Canada Foundation - <u>www.biocap.ca</u>	David Suzuki Foundation - <u>www.davidsuzuki.org</u>
Biofleet - <u>www.biofleet.net</u>	Environment Canada, Environmental Technology Directorate - <u>www.ec.gc.ca/etad</u>
Biomass Energy Research Association – <u>www.biomasscenter.org</u>	Friends of the Earth Canada - www.foecanada.org
Bioportal - <u>www.bioportal.gc.ca/english/BioportalHome.asp?x=1</u>	Greenpeace International- <u>www.greenpeace.org</u>
BioProducts Canada Inc <u>www.bio-productscanada.org</u>	National Research Council - www.nrc-cnrc.gc.ca
BioQuebec - <u>www.bioquebec.com</u>	Natural Resources Canada - www.nrcan.gc.ca
BIOTECanada - <u>www.biotech.ca</u>	Ontario Agri-Food Technologies - www.oaft.org
Canadian Chemical Producers Association - www.ccpa.ca	Pollution Proba pollutionproba arg
Canadian Institute for Environmental Law and Policy -	Politikuoli Probe - <u>www.politikuoliprobe.org</u>
www.cielap.org	Sierra Club of Canada - <u>www.sierraclub.ca</u>
Canadian Renewable Fuels Association (CRFA) - www.greenfuels.org	United Nations Environment Programme - <u>www.unep.org</u>



To be good to the environment, we don't need to look any farther than earth's natural resources. What could be better for Mother Nature than products made from plants grown right here in Canada?

Over the centuries, plants have provided food, medicine and shelter. Now the 21st century is enjoying a retro moment, remembering the strength of hemp, the flexibility of many end uses of corn and the versatility of soybeans.

What's old is new again as the Canadian bioproducts industry transforms the sun-locked energy of plants into fibres and fuels, which are environmentally friendly alternatives to petroleum-based products. Essentially, it's biology at work. Bio – the Greek word for living – is now being used extensively in many industries.

The raw materials come mainly from Canadian agriculture, and also from forestry. Farmers are eager to have more than one market for their crops, reducing risk and expanding diversity. In this new era, consider the potential for a 2,000-acre wheat farm that may sell one-quarter of its crop for food export, one-quarter to a domestic pasta plant, one-quarter for ethanol and the remaining quarter to a furniture-making fibre plant. Optimistic? Maybe. Today's farmers are quickly adjusting to producing food, feed, fibre *and* fuel.

Some helpful terms to get started:

Biomass is most often produced by the photosynthetic activity of plants, but can also come from animals. A major agricultural source of biomass is organic materials produced in the processing of a product that is not primarily grown for energy. This can include manure and bedding from livestock, grain handling and harvest residues.

There are two types of biomass: raw biomass and secondary biomass.



Raw biomass consists of forest and crop materials like trees, shrubs, grass, grains, legumes or even manure. The common element is lignins, a major component of cell walls. It's the most common organic polymer on earth, after cellulose.

Secondary biomass is produced from the same sources as raw biomass, but also undergoes significant chemical and physical changes. Often enzymes are added to convert starches to sugars, transforming the biomass into the building blocks for consumer products such as paper and cardboard, leather, cotton, linen, hemp, natural rubber, cooking oils and cheese whey.

Bioproducts are created by processing biomass. Canadian crops such as hemp, corn, soybeans, canola and flax can be turned into biofuel, bioenergy, biomaterials and biochemicals – all environmentally friendly alternatives to most of our current petroleum-based products.

Fossil Fuels are drawn from ancient plant and animal remains that have been heated and exposed to pressure deep within the earth. Coal, oil (petroleum) and natural gas are the most common types of fossil fuels which supply about 90 per cent of the world's energy needs. Carbon is the main element in fossil fuels and when burned, the carbon changes into carbon dioxide, the element that contributes to global warming.

Feedstock refers to the raw biomass that is processed to create bioproducts. Examples are wheat straw, hemp stalks, canola oil and corn kernels.

Bioproducts

may sound like new inventions, but we can already find them all around us! Crops like corn, soybeans, flax and wheat can be converted into useful fibres. Many household items we use every day can be made from renewable agricultural sources. We can immediately grow more crops to replace what we are using, unlike crude oil and natural gas, which take thousands of years to form.

In fact, almost anything that comes from a barrel of petroleum can be made from a bushel of corn or soybeans. Making the same items that currently come from petroleum-based materials with biological resources means a cleaner, healthier environment.

BEDROOM

CLOTHES IN CLOSET

Bioproduct:	hemp, flax, other
Replaces:	polyester (manufactured fibre)
DEDCHEETC	

BEDSHEETS Bioproduct:

oproduct: corn Replaces: polyester (manufactured fibre)

PAINTS AND CRAYONS (KIDS BEDROOM)

Bioproduct:
Replaces:Plant dyes and soy wax
chemical dyes and paraffin wax (a petroleum product)

DISPOSABLE DIAPERS

Bioproduct: cornstarch Replaces: plastic

GARAGE

CAR PARTS (VARIOUS)

Bioproduct: corn starch, straw Replaces: polystyrene seat filling, synthetic airbag filling, plastics

FUEL IN CAR

Bioproduct: Replaces:

ethanol from corn starch or cellulose gasoline from oil

GARDENING TOOLS

Bioproduct: polylactic acid (from corn starch) Replaces: plastic

LIVING/DINING ROOM

RUG/CARPET

Bioproduct: Replaces:

t: corn, other plant fibres s: synthetic fibres

TABLETOP & VARNISH

Bioproduct:hempseed oil and beeswaxReplaces:Polyacrylates (acrylics)

PAINT

Bioproduct:

Replaces:

milk protein (casein) paints or paint with no- or low-VOC content (Volatile Organic Compound, which is carbon-based) oil-based paints

HOUSE STRUCTURE OVERALL

SHINGLES Bioproduct:

oproduct: blend of wood flour, flax straw and recycled rubber and plastics asphalt

INSULATION

Bioproduct: Replaces:

foam made with straw, protein, glue Polystyrene (petroleum-based foam)

HEATING

Bioproduct: Me Replaces: Na

Methane from animal or municipal waste Natural gas

ELECTRICAL POWER

Bioproduct: Replaces: wood or plant fibres coal, oil, natural gas

BATHROOM

FLOORING	
Bioproduct:	Cork, jute, flax
Replaces:	Polyvinyl chloride (PVC
Replaces:	Polyvinyl chloride (PV

COSMETICS, SHAMPOO

Bioproduct: Replaces: wheat, oats, corn synthetic chemical ingredients

KITCHEN

CUPBOARDS

Bioproduct: Replaces: wheat straw, flax or soybeans medium-density fibreboard (MDF), other processed woods

COUNTERTOPS Bioproduct:

Replaces:

hemp plastic laminate



One of the most well-known and widely discussed bioproducts is biofuels, which have been created to supplement, or maybe one day replace, fossil fuels. They are liquid fuels made from biomass, like biodiesel (a substitute for diesel fuel) and ethanol (a substitute for gasoline).

Farmers and food processors already handle large volumes of energy-rich organic material, so the logical next step is to process that feedstock into energy we can use.

In Canada, ethanol is most often produced from corn or wheat feedstocks. Biodiesel is produced from canola for use in biodiesel engines. The lubricity of canola oil that makes it healthy for flowing through heart arteries is the same characteristic that makes it desirable for flowing through truck valves in cold temperatures. Look for city buses that may be already using biodiesel and proudly communicating that through the BioBus logo.

Biofuels are considered "carbon neutral" because the same amount of carbon dioxide is emitted into the atmosphere when it is used as the plant it came from absorbed when it was growing.

While Canada is still early in building biofuel capacity, Brazil has been a leader in ethanol production for 30 years capitalizing on its sugarcane. This equatorial crop produces more biomass per acre than any other crop in the world and is therefore highly prized for its economy in producing both food (sugar) and fuel (ethanol). While North America is quickly building biofuel plants fed by crops that produce less biomass, industry experts readily admit that wood cellulose or switchgrass hold more promise in the long term. Scientists are still perfecting the most economic way to convert these feedstocks.



Canada's role in biofuels and the Impact on the Future

In December 2006, the Canadian government announced a new regulation for diesel fuel: by 2012, all diesel fuel and heating oil must contain a minimum of two per cent biodiesel.

This may not sound like much, but according to a University of British Columbia study, one litre of diesel generates the equivalent of 4 kg of carbon dioxide. On the other hand, the same amount of biodiesel generates 0.5-1 kg of carbon dioxide. This means that if we can replace two per cent of the 600 million litres of diesel consumed in Canada every year, our total greenhouse gas emissions will be reduced by 1.8 million tonnes. That is the equivalent of taking 300,000 cars off the road!

New regulations pertaining to the renewable content of gasoline have also been announced by the government. By 2010, 5% of gasoline must consist of ethanol. This would require Canadian companies to produce about 2 billion litres of ethanol per year; in 2007, they produced an estimated 1 billion litres of ethanol, but new processing plants are being built every day.



Many researchers believe a more sustainable fuel is cellulose ethanol. Traditionally, ethanol has been produced from the starch in grains such as corn, wheat, barley and sorghum. However, new studies and tests are making use of the cellulose found in plants and other biomass. Cellulosic ethanol is even more effective than traditional ethanol in reducing greenhouse gas emissions.

For example, replacing regular gasoline with cellulose ethanol can reduce greenhouse gases emitted during production and as vehicle exhaust fumes by more than 80 per cent, as compared to the 30-40 per cent reduction from conventional ethanol.

This new regulatory environment as well as rising commodity prices are encouraging farmers to produce as much biomass as possible. Every Canadian farmer must assess what crops are most profitable depending on individual situations and proximity to either food, fibre or fuel processing plants. Their decisions are not as simple as whether to produce food or fuel, but what crops are the best fit for their soil rotations to prevent disease and weeds while making a living.

Debate has arisen about the capacity of farmers to produce both food and fuel on ever dwindling arable land. Will food crops be diverted to fuel? Will food prices rise as a result? To date, the most sought after crop, corn, had North American carryover stocks despite record production in 2007. Supply is still outstripping demand, with an estimate of 20 percent of the corn crop now going towards biofuel.

New technologies such as biotech-improved seed are allowing farmers to grow more per acre while reducing fuel and herbicide use. As stewards of the land, farmers realize that growing more must be done sustainably.



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For more information:

"Primer on Bioproducts" by Pollution Probe and **BIOCAP** Canada http://www.pollutionprobe.org/Reports/ bioprimer(en).pdf

Bioproducts at Guelph http://www.bioproductsatguelph.ca

Bioproducts Canada http://www.cleanenergy.gc.ca

Canadian Renewable Fuels Association http://www.greenfuels.org

Genome Canada http://positionpapers.genomecanada.ca/ pdf/bioproducts.pdf

Ontario Bioproducts http://www.ontariobioproducts.com

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