Summer 2006

GO BIO

Highlighting bioproduct innovation in Ontario

Towards cleaner air

Bioproducts are poised to make a big impact on the environment and the farm economy

ALSO INSIDE

Innovation is inevitable

Dr. Gord Surgeoner

The Premier of the Province of Ontario, Dalton McGuinty has said "we will create an environment where innovation is inevitable".

This is our collective vision which has and will continue to be backed by action.

An important first step was the Premier making himself the Minister of Research and Innovation.

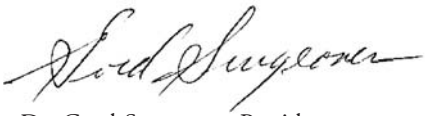
World-class research is the foundation for success. In this magazine you will find examples of great research being conducted by scientists in Ontario. There is a strong recognition that both the public and private sector conduct research. A number of programs are in place to encourage win-win public-private partnerships.

Research without implementation provides little in terms of revenue generation, jobs and products that give value to our citizens. Programs for innovation exist to commercialize research with our private sector partners. We recognize that research is global and have developed national and international partnerships that create synergies between provinces and nations.

In the agri-food sector, our mission is to create opportunity for profit for our primary producers. We are doing this by focussing on new market opportunities for the agri-food sector to deliver improved health, new sources of energy and new advanced biomaterials to compliment our manufacturing sectors, particularly automotive.

These are exciting times, in an exciting jurisdiction; Ontario, Canada.

Enjoy the articles enclosed.



Dr. Gord Surgeoner, President
Ontario Agri-Food Technologies

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Go.BIO is designed to build awareness and understanding of Ontario's bioproduct research activities and accomplishments. Research depicted in Go.BIO is sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs.

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Car, by nature

Researcher incorporates natural plant strength into manufactured fibres

By Rebecca Moore

Biofibres could improve synthetic materials and limit crude oil dependency and use, says a University of Toronto researcher. Prof. Mohini Sain, Faculty of Forestry, is tapping into this potential by using natural fibres to create stronger materials for car parts, packaging and aerospace, and he's attracting attention from large manufacturing companies.

Sain has developed a novel technique to extract fibre from biological sources such as plants and trees to boost the properties of synthetic materials. He says extracting and applying biofibres to these materials creates a stronger, lighter and renewable alternative to petrochemical-derived materials.

"Biofibres have tremendous potential in material manufacturing," says Sain. "Today we can make fibres with the performance requirements that many industry sectors are demanding, while being environmentally friendly."

His biofibre technology has been used to develop car prototype components such as exterior panels, hoods, car seats, running boards and side panels. Canada's largest car parts manufacturer, Magna International, noticed Sain's work and has partnered with him to help mass produce the auto part prototypes for commercialization. He hopes his biofibre technology will be a part of the automotive industry culture within the next one to three years.

The uptake of this technology by car and truck manufacturers could be influenced by the environmental nature of biofibres. Currently, fibreglass, plastic and other synthetic materials are the standard, and they're derived from oil-intensive production practices. Sain touts biofibres as an economical and environmentally friendly alternative to these petroleum-based materials.

He isn't stopping at car parts. Sain wants to branch out from the automotive industry and apply biofibre technology to aerospace components, electronics manufacturing, biomedical applications and packaging.

He sees the packaging market in particular as a strong opportunity because 40 per cent of all plastic is used for packaging. Sain has his sights set on cutting into 70 to 80 per cent of this specific market.

Sain is now looking closer at biofibre incorporation by developing another process to extract nanofibres (extremely small fibres) from plants. This technology could be applied to niche markets in aerospace manufacturing and for biomedical applications such as surgical gloves and blood bags.

To communicate the merits of biofibre technology and help get products past the research phase, Sain has established the Centre for Biocomposites and Biomaterials Processing to build further awareness of biofibres, bioplastics and biocomposites technology.

This research is sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs, AUTO21 Network of Centres of Excellence, Ontario Centres of Excellence, and the Natural Sciences and Engineering Research Council. **GB**

Wellington Polymer Technology Inc.

St. George's Church, a heritage site in Sutton, ON, sports an environmentally friendly Enviroshake roof. The bioproduct has the same look as the old cedar roof it replaced.

Arthur Churchyard

Vehicles like these will be built with more parts containing plant fibres, making them stronger, lighter and more environmentally friendly.

Shaking up the shingle industry

Waste materials find new life as bioproducts

By Arthur Churchyard

Wood flour, flax straw, tire-derived rubber and recycled plastics are just a few of the innovative ingredients being processed and blended to make Enviroshake, a recycled roofing product that has been appearing on everything from church steeples to cottage roofs across North America.

Jim Nash, president of Wellington Polymer Technology Inc. of Chatham, ON, which makes the new breed of shingles, says Enviroshake is helping to open doors for others in the bioproduct's supply chain. He says the roofing and agricultural industries can benefit from using dependable, renewable sources of raw materials such as straw fibres to make a stronger, environmentally friendly shingle.

"There needs to be more focus on bioproducts and increased use of agricultural materials," says Nash. "Industries must become more sustainable, and producers have a lot to gain from growing diversified crops."

Wellington Polymer has made heavy investments in bioproduct research since the company was established in 1998. Its current success, fuelled by Enviroshake demand that has doubled to 600 projects in the last year, stems from ongoing research and development into the chemistry and processing of agricultural fibres.

"Wellington Polymer has spent more than six years developing superior composite blends and formulations because we believe in the rewards of bringing high-quality, scientifically sound products to market," says Nash.

Research was essential in blending recycled and agricultural materials to make Enviroshake, which also incorporates dyes to simulate a cedar look. By putting existing resources to new use, the shingle is environmentally friendly. It can be reused and reduces dependence on oil by using recycled plastics during manufacture.

Enviroshake shingles can be installed over existing roofing material to save waste from going to landfill. Installation requires only a power nailer and standard roofing nails, and no additional treatment is needed afterwards. The product lasts more than 50 years, resisting mould, mildew and insect invasion.

For such a long-lasting, low-maintenance shingle, Enviroshake is surprisingly similar in initial price to the high-end cedar shake it resembles. But given its longer life cycle, in a 50-year period the Enviroshake roof will incur half the costs of an authentic cedar roof. That's one reason Wellington Polymer is scrambling to meet demand for the shingle.

While bioproduct research is paying off for the company, it is also adding value to farmers' crops. Straw from hemp and flax, previously discarded as waste, is now being sought by firms like Wellington Polymer to create new bioproducts. The long, durable fibres contained in the inner core of the straw are ideal for making tough materials such as shingles.

Opportunities to supply raw material sources for bioproducts are growing. Enviroshake, in particular, is made from more than 95 per cent recycled and renewable materials such as old tractor tires and crop residues, but Nash says the supply of agricultural products like hemp and flax straw is limited in Ontario. He encourages producers to think outside the box when choosing which crops to grow, so they can capitalize on new markets.

"Enviroshake is something that is here to stay," he says. "Producers should take a serious look at the industry to see how they can get involved in bioproducts." **GB**

A facelift for filters

Researchers to put bioactive components on paper surfaces

By Robert Fieldhouse

New filters being developed from biologically active paper that can detect and capture harmful agents have a strong potential to improve Canadians' health and safety, says a University of Guelph researcher.

Prof. Chris Hall, Department of Environmental Biology, says the specialized filters he and his collaborators are creating could be used to actively remove water contaminants, purify disease-causing antigens for medical research, prevent undesirable agents from entering emergency blood supplies, protect citizens from bioterrorists, and filter air in cars.

"We're trying to make various reagents that will bind to paper and essentially capture and detect pathogens and organic contaminants," says Hall. "The real difficulty is getting whatever it is that binds to pathogens to bind to paper, too."

Current filters rely mostly on small pores that block contaminants from passing through based on their size, says Hall. But now the goal is to create advanced filters that will actively remove unwanted components in a variety of situations.

Most filters are based on cellulose, a carbohydrate that's the main component in paper.

Office of Research, University of Guelph

Prof. Chris Hall (right) is borrowing enzymes that normally bind to plant cellulose to develop biologically active paper that can filter harmful particles such as disease-causing agents and water contaminants.

The new filters will feature special proteins that stick to cellulose. The proteins will have two parts: one called a cellulose binding domain (CBD) to bind cellulose, and the other an antibody to bind pathogens and other contaminants.

Hall says the protein's CBD will be borrowed from enzymes that normally bind to cellulose and degrade it. Then, using molecular biology tools, Hall and his team will create "fusion proteins" that replace the degrading component with an antibody that recognizes and fuses to harmful agents, anchoring them to the filter surface and preventing them from passing through the paper's pores.

This type of filtering goes beyond just using size to exclude undesirable materials. For example, a SARS-fighting antibody could be linked to paper through a CBD. This paper could then be used to supply health care workers with SARS masks that prevent them from inhaling the virus by trapping it first, says Hall.

He is investigating antibodies designed to capture and detect several species, including *Escherichia coli* and *Pythium*. His first test will be to see whether his fusion proteins can be applied to water filters that specifically target these organisms that cause human or plant diseases.

This five-year project is still in its early stages, with preliminary results just beginning to flow in. By the project's end, Hall hopes it will be possible to print his bioactive agents onto paper to create the novel filters and other similar products. He says paper is perfect for many applications because it's inexpensive, disposable and can be made sterile.

"It's absolutely amazing," says Hall. "Paper can be used to do just about anything. What we really want to do is build a platform for rapidly detecting pathogens by optimizing its use."

This project is a Natural Sciences and Engineering Research Council initiative called SENTINEL, a Canadian Network for the Development and Use of Bioactive Paper. It brings together a diverse group of researchers who have expertise in the biosurface and biomaterial sciences.

Others involved include Prof. Mansel Griffiths, Department of Food Science; Prof. Stephen Seah, Department of Molecular and Cellular Biology; research associate Michael McLean, and graduate students Greg Hussack, Melissa Bassoriello and Sarah Wood, Department of Environmental Biology; and Dr. Roger MacKenzie, National Research Council Canada.

This research is sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs, Sciences and Engineering Research Canada, the SENTINEL Network and its industry partners. **GB**

Bio-paint, with less chemical taint

Paint and ink producer trades petroleum ingredients for plant-based technology

By Arthur Churchyard

Paint and ink manufacturers worldwide are expanding their palette options using agricultural resources. An Ontario company that distributes ingredients to global manufacturers of surface coatings is now marketing a plant-supplemented ink product that costs less, performs better and will ultimately create a market for more crops.

Lorama Chemicals Inc. is using a unique processing technique that replaces petroleum with plant polymers to make better paint and ink ingredients. The most recent application of the technique has led to an ink component called InkRes33, which can save coating manufacturers up to 10 per cent of production costs.

"For businesses deciding which paint components to use, it's the dollars that count," says Ruben Lenz, director of research and development at Lorama. "There are definite social and environmental advantages to our products, but our success comes from saving manufacturers money."

The money-saving secret of InkRes33 and other Lorama coatings lies in a technique called polysaccharide resin technology. This technique uses a liquid polymer from plants instead of a petroleum-based binder in the paints and inks. A binder is the expensive ingredient added during processing that later binds colour and texture to surfaces. Inexpensive diluents such as water or alcohol are also added to help spread the coating during application.

Typically, coating manufacturers reduce production costs by using more diluents and less binder. Now, the polysaccharide resin further reduces the amount of binder needed because it can better expand to fill blank spaces left by evaporating diluents – an advantage over petroleum-based binders, which need more raw materials to fill those spaces.

Polysaccharide resins and other organic paint components can be derived from potatoes, corn and most cereals. The agricultural sector could get a boost from growing high-value crop varieties for use in Lorama products, says Lenz. For example, a specialized corn variety marketed for use in InkRes33 could bring a higher price per bushel than other corn varieties that could be grown on the same land.

InkRes33 also benefits print operations. Traditional binders come in a powder form that can eventually cause clogs during long print runs. The liquid form of InkRes33 means less clogging and longer print running times. The product also has fewer volatile organic compounds, which are known to damage human health in enclosed spaces and contribute to smog and ozone depletion.

With benefits at every level of the coating industry, Lorama's bio-based products have been doing well. The company has been experiencing double-digit growth rates for decades, following its initial investment in bioproduct research in 1978.

Lorama partners with the Ontario Corn Producers' Association and the Ontario Ministry of Agriculture, Food and Rural Affairs in further bioproduct research. **GB**

Paint and ink could be joining the growing legion of products containing plant-derived components.

Kyle Rodriguez

Economical ethanol production

Enzymes are called into action to increase glucose production

By Rebecca Moore

Ethanol production relies heavily on one component: glucose availability. This simple sugar, stored as complex carbohydrates in plants and feedstock, is considered the liquid gold of the biofuel industry because it can be fermented to create ethanol. Enzymes are necessary to tap into the plant's energy reservoir by breaking down the carbohydrates (starch and cellulose) to create glucose. But the enzymes' activity rate is often the limiting factor in ethanol production.

Now, University of Toronto Prof. Bradley Saville is helping enzymes function more quickly and efficiently, to make large-scale ethanol production more economical. A member of the Department of Chemical Engineering and Applied Chemistry, Saville is looking at ways to increase the performance of cellulase, amylase and glucoamylase, the enzymes involved in breaking down cellulose and starch.

If he succeeds, his efforts could help reduce the cost of ethanol production, allowing the environmentally friendly alternative to gasoline to become a more cost-competitive option.

"Enzymes are critical, highly specific catalysts that are absolutely necessary for the creation of biofuels," says Saville. "Increasing the activity of cellulase and other enzymes that can be limiting production factors will help decrease the production cost of ethanol."

When cellulase is exposed to plant material, it digests cellulose and releases glucose. Eventually, it gets saturated and stops digesting. Saville's research team wants to alter the enzyme so it has a higher affinity for cellulose and can be reused.

He is also focused on amylase and glucoamylase – enzymes that are involved in starch breakdown. He would like to slightly alter the enzymes to have a higher heat tolerance, so they stay active and increase glucose production.

Besides being the precursor to ethanol production, glucose is the starting point for a variety of other bioproducts, including fabrics and plastics, says Saville.

"I think we have an absolutely wonderful opportunity to take a renewable resource and make something good for society that helps to reduce our ecological footprint," he says. **GB**

An innovation haven

Institute promotes cost-effective and environmentally minded developments

By Rebecca Moore

Having access to technical and scientific expertise can be a significant resource for new bioproduct ventures. To that end, the Institute for Chemical Process and Environmental Technology (ICPET) in Ottawa, Ontario, serves the industry with its mandate to conduct research into innovative processes and new environmental technologies.

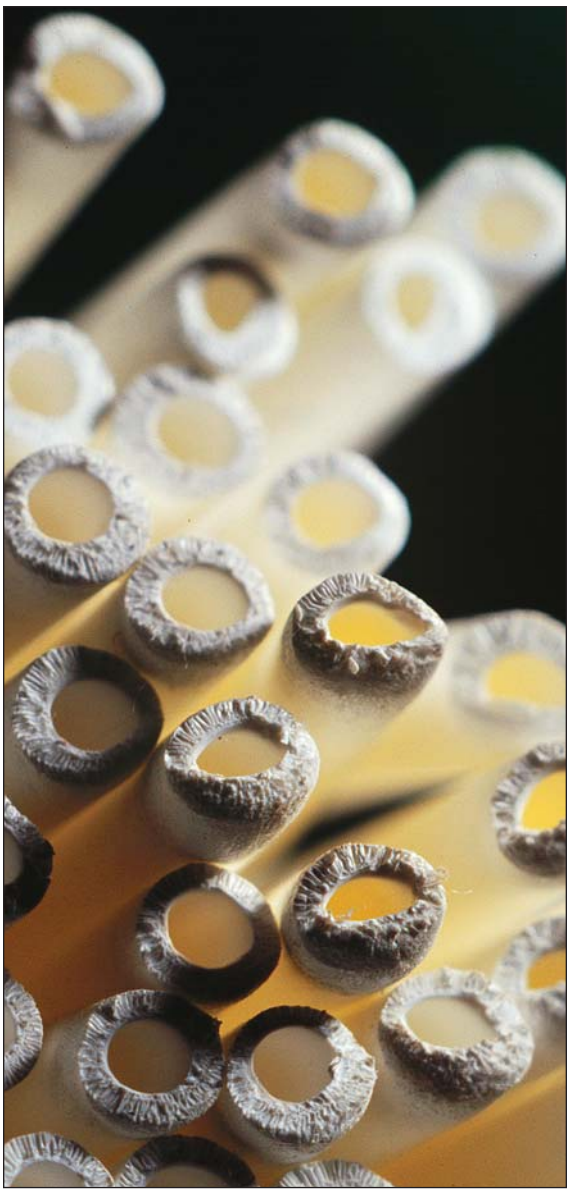
Kevin Jonasson, the institute's director of commercialization, says ICPET is focused on supporting development in three sectors – bioproducts, fuel cells and oil sands – in which chemistry is a key component in the value-added transformation of materials. He says the institute is ideally positioned to help companies develop novel processes and products in conjunction with industry partners and educational institutions.

"ICPET is a great resource because it has unique facilities and an excellent group of researchers from a wide variety of scientific backgrounds," he says.

The institute is a research body of the National Research Council, a Crown corporation of the Government of Canada. With its links to academia and industry from coast to coast, the institute can be a great asset to help develop bioproduct technology.

Its doors are open for collaboration. Jonasson says companies can approach the institute for assistance in finding innovative solutions to challenges. For example, natural food ingredient company Colarôme Inc. of Montreal approached the institute in 1999, needing help to find a novel process to refine its food-grade colourant. The ICPET team not only found a solution using membrane filtration technology, but it also helped revamp the company's processes to decrease production time by 33 per cent, saving resources and fuel.

Now, the institute is working to create a unique high-quality foam from a substance called polylactic acid, derived from corn. Jonasson says this material will be highly functional and is expected to have many manufacturing applications in aerospace engineering and automotive manufacturing, among others. **GB**



National Research Council

Membranes such as these are developed by the institute for various applications, including food processing and nutraceutical production.

From fat to fuel

Animal fat-based biodiesel set to hit the pumps

By Rebecca Moore

Motorists fuelling up with biodiesel could soon be relying on an unlikely energy source: animal fat. A University of Toronto researcher has found a way to use materials from the animal rendering and food service industries as the basis for biodiesel production. His work has caught the eye of a biodiesel company that is now bringing the product to market.

Prof. David Boocock, Department of Chemical Engineering and Applied Chemistry, developed a novel technology to convert seed oils, animal fats and recovered cooking oils to biodiesel. By doing so, he has created a product that's more environmentally friendly and sustainable than conventional fuels while being more economical than conventional biodiesel technologies.

"Biodiesel is to diesel what ethanol is to gasoline," says Boocock. "Alternative fuels that are more environmentally and economically sustainable will be the future."

To develop the technology, he had to overcome a major problem associated with using fats and oils as fuels. Because these materials contain fatty acids, they did not react well with the conventional process to produce methyl esters (the chemical component of biodiesel). So, Boocock derived a step to first convert fatty-acids to methyl esters.

His conversion process also includes a co-solvent that drastically increases the speed of biodiesel production. Armed with this technology, he began to apply his work to find cheaper feedstock sources than the refined vegetable oils, which actually cost more than the diesel they produced.

Boocock came up with the idea of using this technology to convert rendered material to biodiesel in the wake of the bovine spongiform encephalopathy outbreak in 2003. At the time, markets for rendered products plummeted and the material piled up. His technology provided an alternative market for the fats and oils and a promising new base for biodiesel production.

Boocock approached the University of Toronto's Innovations Foundation to seek out opportunities to commercialize his work. His development caught the eye of BIOX Corporation, a biodiesel company based in Oakville, ON, which bought the patent for the technology. BIOX has now constructed a 60-million-litre-per-year commercial plant in Hamilton, ON.

Biodiesel's future looks promising. It's cleaner-burning, sulphur free and releases less carbon dioxide. With a new Environmental Protection Agency (EPA) mandate to reduce sulphur in diesel by June, 2006 from 500 parts per million to 15, biodiesel will be a welcome addition to the pumps – its structure maintains appropriate lubrication levels that would otherwise be lost in the conventional sulphur removal process.

"Biodiesel is here to stay," says Boocock. "It contributes to cleaner-burning fuels and solves the environmental problem of what to do with rendered fats and oils." **GB**

Iogen Corporation

Cleaner fuel from waste material

New technology turns plant waste into cellulose ethanol

By Heather Filby

The enzymes being examined by this Iogen researcher are necessary to break down the cellulose in plant fibres to make cellulose ethanol.

A new process developed by a Canadian company is turning crop residues such as wheat straw, cornstalks and prairie grass into cellulose ethanol, a clean-burning fuel that's good for the environment.

Iogen Corporation in Ottawa, ON, which is credited with being at the leading edge of cellulose ethanol development in the world, says the fuel's production merits are many. It doesn't disrupt the food supply (conventional ethanol uses crops for fuel instead of nutrition), it provides farmers with an extra source of income, and it has more long-term environmental benefits than conventional ethanol made from corn and other grains.

"Cellulose ethanol is a source of clean, sustainable and home-grown energy," says Tania Glithero, marketing and communications coordinator. "It addresses current concerns about global warming, energy security and the economic development of rural communities."

Cellulose ethanol is produced using enzymes from the fungus *Trichoderma reesei*. Iogen's process starts with a feedstock such as wheat straw being pulverized and treated in a steam bath to open up the plant fibre, or cellulose. The enzymes are then added to break down the cellulose into glucose.

The glucose is separated from the solid matter, most of which is lignin. Lignin can be burned for energy production – a clean alternative to fossil-based sources such as coal. The glucose is fermented and distilled to 199-proof alcohol. One per cent gasoline is added to create the final ethanol product that can be used as a transportation fuel.

To test the feasibility of large-scale production, Iogen has constructed a large-scale cellulose ethanol demonstration plant in Ottawa – the first of its kind in the world. The $45-million plant produces about 12,000 litres of ethanol a week, from 40 tonnes of wheat straw supplied by local farmers.

Glithero says because cellulose ethanol is a high-octane fuel containing 35 per cent oxygen, it can be readily used as an alternative fuel in vehicles. She says all vehicles can use a blend that contains 10 per cent ethanol, and flexible-fuel vehicles manufactured by companies such as Daimler Chrysler, Ford and General Motors can use up to 85 per cent ethanol.

Replacing regular gasoline with cellulose ethanol can reduce greenhouse gases that are emitted during production and as vehicle exhaust fumes by more than 80 per cent, says Glithero. That's even more than conventional ethanol, which can reduce greenhouse gases by 30 to 40 per cent.

Although the demonstration plant is a learning facility, Iogen plans to build a full-scale commercial plant in the near future. Three possible sites are being considered: two in the Canadian Prairies and one in the United States.

Because the technology is relatively new, and because Iogen's demonstration plant is the world's only large-scale producer of cellulose ethanol, the cost per litre of cellulose ethanol is still higher than the cost of both conventional ethanol and regular gasoline. But that's about to change.

With the construction of full-scale commercial plants, cellulose ethanol will enter the marketplace competitive with conventional ethanol and, in the longer term, will become competitive with gasoline pre-tax.

In the future, Iogen plans to provide licences for its patented technology to worldwide operations.

Iogen's cellulose ethanol research is supported by the Government of Canada, Petro-Canada, the Royal Dutch/Shell Group, and Goldman Sachs & Co. **GB**

University of Guelph

Better diets for pigs to improve their health and growth could be on their way, using dried distillers grains with solubles, a byproduct of ethanol processing.

Fuel for hogs

Ethanol byproducts can be economical for pork production

By Brita Ball

Ethanol is emerging as an environmentally friendly alternative to regular fuel. But as more ethanol plants are built to meet demand, more byproducts – such as dried distillers grains with solubles (DDGS) – are produced. One University of Guelph researcher is looking at how these "co-products" can be used in livestock rations, providing farmers with a cost-efficient source of protein and energy.

Currently, most co-products are used in beef and dairy cattle rations. But Prof. Phil McEwen's new research at the University's Ridgetown Campus has identified ways to incorporate them into diets for swine and veal calves as well.

"We must use these products to our advantage in livestock feeding," says McEwen. "It's a great way to cut back on waste and provide animals with good nutrition."

During ethanol production, the starch from a feedstock is converted to ethanol. Corn is a commonly used feedstock because approximately 60 per cent of it is a highly fermentable starch. The remaining components, including oil, protein and fibre, become co-products such as DDGS or condensed distillers solubles (CDS). Because of an increase in ethanol production, McEwen says these co-products are now more widely available, so he's studying how best to fit them into swine rations.

He conducted his research with DDGS from an ethanol plant in Chatham, ON. It produces 400 metric tonnes of DDGS each day – enough to fill 10 to 12 semi-trailers. Close to 85 per cent of that goes to feed cattle, and only a small amount of the remainder has been fed to other livestock.

But, other industry sectors could benefit from DDGS, too. McEwen has shown that hogs maintain their feed efficiency and have similar growth rates as pigs fed rations without DDGS. As well, they have the same carcass and meat quality attributes. Feed intake also stays the same, he says, so incorporating DDGS at 20 per cent of the ration doesn't affect feed flavour or palatability. However, he says, more research is needed to determine whether DDGS can be cost-effective at higher levels.

Ontario markets 4.8 million hogs each year, creating significant potential for more DDGS to be fed to swine.

While McEwen's research has shown the value of feeding DDGS to hogs, other benefits exist for using it in swine production. Ron Lackey, a livestock feed specialist for the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), says feeding DDGS to sows helps prevent ileitis, a gut disease.

"DDGS provides a good fibre source, which is important in sow diets," says Lackey.

In another study, McEwen used CDS in a grain-fed veal calf feeding trial. Although CDS is sometimes difficult to work with, his research has shown that even a five per cent ration inclusion rate can reduce feed costs, and the cost of weight gain in calves. He hopes to identify ways to better incorporate higher levels of CDS into veal diets.

McEwen's research was supported by Ontario's Alternative Renewable Fuels Research and Development Fund, managed by OMAFRA, and Commercial Alcohols Inc. **GB**

Putting waste to work

Efficient digestion process could offer economic, environmental benefits

By Brita Ball

Using farm animal manure to produce biogas could enhance the sustainability of farming, protect the environment and create new economic opportunities in rural areas, says a University of Guelph research engineer.

Ron Fleming of the University's Ridgetown Campus is studying an anaerobic digestion process for manure. During this process, methane is produced and can be used to generate electricity and heat. The anaerobic digestion process also produces a nutrient-rich material that can be safely spread on fields.

"Biogas is a win-win situation for the farmer and society," says Fleming. "It provides a sustainable way to produce energy and creates a more environmentally friendly form of livestock manure."

In this system, manure from livestock farms is put into an airtight vat, into which bacteria are introduced. After three weeks, the anaerobic bacteria convert various manure compounds into methane gas and carbon dioxide and leave a slurry solution.

Methane can be used as a fuel; in this case, it's burned to power a generator, which produces heat. The heat created from the generator can be captured and used to warm the digester, to help the digestion process. Or it can be used for other useful purposes, such as heating buildings. The slurry can be used as an environmentally friendly fertilizer: the digestion process kills harmful bacteria and removes odours from the slurry, making it more acceptable to neighbours than untreated manure.

Fleming is working to optimize pig manure digestion, using an 8,000-litre pilot-scale digester. He's testing "recipes" of manure and other materials to determine the cost-effectiveness of digestion with various mixtures. As well, he's conducting side-by-side trials of anaerobic digestion and traditional composting to compare the energy inputs and outputs, volumes and nutrient content of various materials.

In one project, he's combining manure with waste material from mushroom production. Spent mushroom substrate can be stockpiled and spread on fields, but the Canadian Mushroom Growers' Association is looking at other options to deal with the large volumes of material produced on some farms, and to be prepared for potential government restrictions on storage and spreading.

Fleming says adding off-farm materials that are high in carbon, such as food-processing wastes, can dramatically increase methane yield, compared with manure alone.

Food processors that separate suspended solids from waste water to improve its quality can send the organic materials to on-farm systems where they can be digested with manure. He says meat plant waste would be another welcome raw material in a manure digester.

"It's such a shame that some food processors are spending considerable amounts of money to dispose of the material in landfill sites," says Fleming. "With more digesters, farmers could be paid tipping fees, making it more worthwhile to have digesters."

There are two existing anaerobic digesters on Ontario farms and only a handful in all of Canada. In comparison, Fleming says there are 3,000 units on farms in Germany, where electricity prices are higher and government policies encourage the technology and allow the use of off-farm materials.

Kim Waalderbos

Waste from mushroom operations is being mixed with pig manure and broken down to create a biogas to generate electricity and heat.

Rendering waste useable

Student innovations recycle animal and food service byproducts

By Brita Ball

The discovery of bovine spongiform encephalopathy (BSE) in North America had a ripple effect throughout the food sector. One of the most affected services was the rendering industry, which handles and recycles animal processing byproducts. Ontario generates enough such material from processors, manufacturers, the food service sector and farms to fill Toronto's cavernous Rogers Centre in eight months. And with increasing food safety legislation, companies needed to look for uses and markets for this material.

Coincidentally, when Canada's first BSE case made headlines in May 2003, Rothsay Recycles, one of Canada's largest rendering companies, and the University of Guelph were already well into plans for a program to involve students in new market directions. That year, the partners announced the Guelph Creative Recycling Initiative (GCRI), a contest designed to encourage students to create new uses or marketing strategies for rendered products.

A unique line of art supplies made from yellow grease and tallow earned students Lee Weiss and Andrew Fata top honours in the 2006 Guelph Creative Recycling Initiative.

Kyle Rodriguez

Here's how it works. Early in the fall semester, student teams choose a rendered product they'd like to work with, such as tallow, yellow grease (used cooking oil), feather meal and meat and bone meal. They generate an original idea about its use, and over the fall and winter semesters, they follow the idea through to completion, with guidance from a faculty mentor. Judges from government and industry assess the students' project reports and presentations and select winners during an awards finale. Participating is a rewarding experience for the students, who get valuable mentoring and advice, not to mention up to $2,500 in prize money.

Since the competition's inception, students have developed many new products from rendered material. In the inaugural year, for example, a winning team of food science and engineering students created concrete using meat and bone meal. The second year saw students create biodegradable, self-fertilizing plant trays and pots made from meat and bone meal. This year, two environmental engineering students won the top award for a project called Eco Art, art supplies made from yellow grease and tallow, as substitutes for oil paints and pastels.

Jeanine Wallace, GCRI project coordinator for 2005-06, says building and construction supplies have been a popular theme for teams. Several students developed a particleboard using meat and bone meal and a tallow-derived resin. Others used feather meal to create soundproof building materials. Students also incorporated feathers into lightweight plastic fence posts and hi-fi speaker cones and poultry fat was an ingredient in sunscreen and a plastic material.

Robin Bonin, product development specialist for Rothsay, says GCRI allows students and Rothsay to grow and learn.

"This is a great opportunity to emphasize the importance of the rendering industry and develop potential new uses for animal byproducts," says Bonin. "It's also great for students to meet industry leaders at the finale to gain exposure for future jobs."

Wallace says GCRI enables students to think outside traditional classroom boundaries and create solutions for recycling food service and livestock waste products.

"It's forward-thinking and innovative for the rendering industry and the university to offer such a program," she says. "Students and the industry can both benefit from it."

GCRI is modelled after the University of Guelph's successful Project SOY (Soybean Opportunities for Youth), which pairs student teams and faculty mentors to develop innovative uses and marketing strategies for soybeans. **GB**

Kyle Rodriguez

Reinforced plastic, developed using meat and bone meal, and feather meal, stands up well under pressure.

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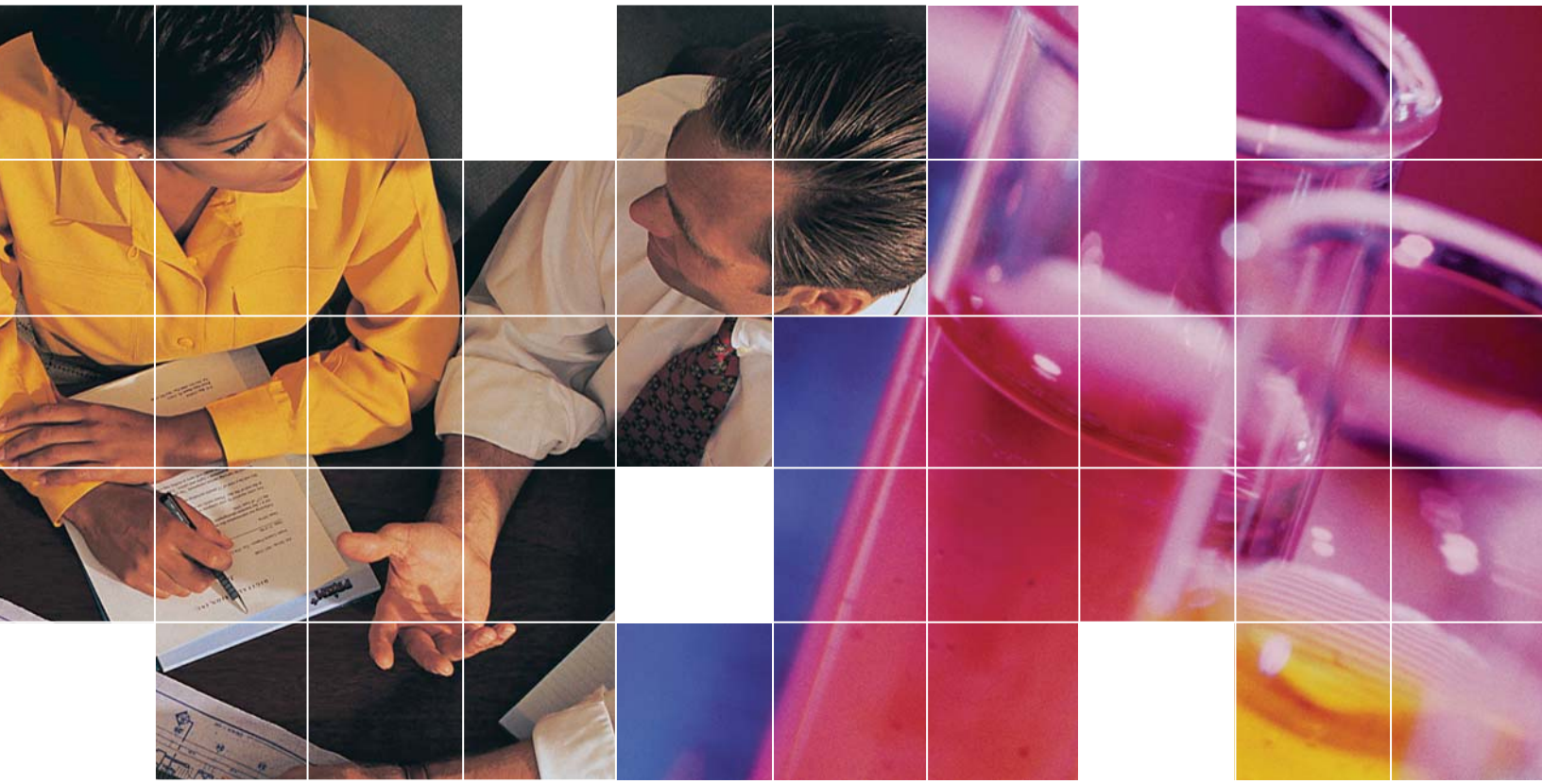

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