

ISSUE1 OF THE BIOTECHNOLOGY SERIES



BIOTECHNOLOGY: BUILDING A BETTER WORLD



WHY CANADA LEADS THE BIO MARKET

Affecting healthcare Healing with "space age" solutions

A global leader Homegrown brilliance in local research parks

Plant power How tobacco is being used as a cure for cancer

Cleaning up chemicals The importance of green chemistry

Research for a remedy The story behind Cold-FX



FUELDE CONTRACTOR OF THE PROPERTY OF THE PROPE

Bedford Biofuel's efforts to create renewable and sustainable forms of oil in Kenya

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CHALLENGES

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"Faced with virtually no money to advertise Cold-FX, Shan opted for a public relations campaign aimed primarily at the media."

How Canada's research parks make a global impact.

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Booming bioindustry A Canadian focus on creating cleane chemistry.

The business of science in Canada is booming,

with a whopping \$84.7-billion dollar value. That's seven percent more than the nation's GDP.

A bio economy is a better eco

t this time of year, as schedules resume with back-to-class enthusiasm, we offer the opportunity to reflect upon an industry that is

experiencing fundamental success and fostering influence on the daily lives of all Canadians. Biotechnology is the platform technology for numerous global products. Canadians are proud vet modest of the contributions our companies are having here at home and abroad. Together, we are creating an enviable climate for innovation.

first-of-its-kind North American plant. The product line of Bio-Amber includes bio-succinic acid derived from corn. This renewable, non-toxic specialty can be further modified to make a wide range of products including automotive parts, biodegradable disposable cutlery, spandex, shoe soles, ingredients for food, flavors and fragrances, cosmetics, engine coolants, as well as salts to melt ice and snow during cold Canadian winters.



Opening the door to choice

With the help of biotechnology, novel foods are making their way from the lab space to the marketplace. These products have been modified to pertain improved health benefits. Food companies have benefited from scientists who were able to identify and eliminate trans-fats. Farmers plant seeds, which are resistant to pests, produce higher yields, and are able to grow in less than ideal conditions such as drought. Bio-products in the international marketplace today include soy-based foams used in the automotive manufacturing, corn based bio plastics, bio lubricants in elevator pulls and jet fuels produced from oilseeds.



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Photo Credit: All images are from

Homegrown success

Recent announcements showcase biotechnology leadership success. Zymeworks of Vancouver has engineered bi-specific antibodies, designed to bind different targets. Dr. Ali Tehrani, president and CEO of Zymeworks, announced a \$187-million deal with Merck to develop the full value of this platform technology across a range of therapeutic indications such as cancer. Homegrown success continues with Montreal-based Bio-Amber, who has selected Sarnia as the location for an \$80-million

The business of science

The business of science in Canada is booming. The bioeconomy has an \$84.7 billion dollar value-more thanseven percent of our national GDP. Canadians in cities and towns across the country are researching, developing, and selling biotechnology products such as bio-therapeutic, agricultural technologies, fuels, new manufacturing and industrial processes. This multi-billion economic impact together with Canada's large natural resource supply and innovative and entrepreneurial population has made Canada into one of the top five global biotechnology markets.

Peter Brenders, President and CEO, BIOTECanada

DID YOU KNOW?

What is biotechology?

Bi-o-tech-nol-o-gy [bahy-ohteck-nol-uh-jee]: is defined as the use of living organisms, or processes including cells, bacteria, yeast, and enzymes to make new products or improve manufacturing. Examples include: pest resistant crops, vaccines, detergents, medicines, bio-fuels, chemicals.

Become involved

We invite you to join us during our 8th annual National Biotechnology Week, as we celebrate Canada's long history of innovative business achievement. Reading through this report you will discover we are in the midst of very exciting times. Learn more about biotechnology in all its forms by joining us in your community for events, conferences, and seminars. Together, these innovations are growing our sustained future.

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DON'T MISS!



Molecules: A medicinal innovation

Biotechnology has come a long way since its beginnings in the 1950's when James D. Watson and Francis Crick deciphered the structure of the DNA molecule. At the time, the discovery was largely ignored by both the media and the public.

Yet today, most scientists consider it to be the most momentous discovery of the 20th century, if not the millennium. Its legacy has led to further discoveries, such as the decoding of the human genome, and innovations which have had a profound impact on human health and the management of serious illnesses.

Importantly, understanding the human genetic code has lead to the emerging field of "personalized medicine" which will allow clinicians to tailor treatment based on individual genetic characteristics as opposed to the trial and error method that typi-

fies today's approach to therapy. It has also allowed scientists to develop highly targeted biologic medicines to treat such diseases as cancer, rheumatoid arthritis, Crohn's disease and blood disorders, to name a few.

Advanced therapies

Biologic therapies are vastly different from traditional pharmaceutical medications. For example, whereas traditional pharmaceuticals are relatively small and simple molecules manufactured through synthetic chemical processes, most biologics are very large, complex molecules or mixtures of molecules manufactured in living systems such as microorganisms or plant or animal cells.

In addition, biologic therapies can be highly target-specific, with the potential to realize high efficacy while producing fewer side effects. For example, a class of biologics known as "monoclonal antibodies" work like naturally occurring human antibodies and can search out the diseased organs or cells that need to be treated with specificity.

"The last twenty years has seen a huge leap in biotechnology innovations," says Dr. Karen Burke, directorof Regulatory Affairs, Amgen Canada and president of the Canadian Society for Chemistry. "We are now able to zero in and treat the root causes of diseases with specific genetic markers that were previously unresponsive to other medicines."

As the future progresses

The next twenty years of biotechnology innovation in human therapeutics will be informed by the further study of genomics which seeks to discover how DNA functions to control cell activities. Understanding cell activities allows scientists and clinicians to diagnose and treat illnesses with ever greater accuracy. In a growing number of cases, Scientists are now able to pinpoint genetic markers in people with certain aggressive cancers and, based on that information, develop treatments to target those specific tumour types. Thanks to the power of biotechnology, Canadians with serious illnesses have greater hope for their future.

"The future of biotechnology is boundless," says Dr. Burke. "Canada is at the forefront of innovation with a strong and vibrant biomedical industry, of which we are proud to be a part. At Amgen Canada, we've spent the last 20 years producing innovations that have helped Canadian patients with serious illnesses and we're excited about the next 20 years which will see even greater innovation in the area of diagnostics and personalized medicines for Canadians."

Types of biotechnology

■ Health: The largest sector of biotechnology, health biotech firms create products including therapies and drugs, vaccines and new diagnostic and testing equipment.

■ Agricultural: Genetic modification of plants and animals is used by agricultural biotechnology firms to combat environmental challenges, and to decrease the environmental impact of agriculture.

■ Industrial: Innovative household and industrial products and techniques developed to provide new solutions for environmental contamination and clean-up, water purification, and biodegradable detergents and solvents

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DAVID LEE

RESEARCH PARKS: HOMEGROWN INNOVATION

Research and development in the biotechnology sector will help determine how globally competitive Canada remains in the knowledge economy, while providing very tangible benefits for people more broadly.

If, for example, the world's population swells to nearly 10 billion by 2030 as experts predict, we will be faced with incremental stresses on our environment and unprecedented needs for food, energy and healthcare-particularly in developing nations. Solutions to many of these problems will be found on university campuses and in research parks and incubators sprouting up across the country.

Across North America, these parks

Local leaders

contribute more than \$31 billion research park is often its incubain annual economic impact to their regional communities, and immeasurable value through new products and processes. Where research parks around the world are often focused on information technology, Canada is home to a number of global leaders in biotechnology.

In fact, from coast to coast, this country boasts 27 research parks that focus their efforts on agriculture and biotechnology. Examples include: MaRS in Toronto, Innovation Place in Saskatchewan, Laval Technopole in Quebec, AgriTECH Park in Nova Scotia, the University of Guelph Research Park and The University of Western Ontario Research Park in London and Sarnia-Lambton.

A key component of a successful

tor, which fosters the development of new ideas and technologies by bringing together expertise from the industrial and academic sectors. Speed-to-market is often a significant advantage of cultivating such environments.

Early support

The University of Western Ontario Research Park, for example, is home to two of Canada's largest biotechnology incubators: the Stiller Centre in London and the Bowman Centre in Sarnia-Lambton. Between them, they provide more than 100,000 square feet of space for early-stage companies and commercialization projects. The Stiller Centre-Canada's 2010 Technology Incubator of the Year-is currently home to more

than a dozen early-stage biotechnology companies that have raised more than \$100 million in venture capital and other investments.

This space has proven critical for developing vaccines and treatments for HIV/AIDS and diabetes, and capitalizes on local strengths in healthcare research. Similarly, the London Campus is home to CImTec, Canada's newly established centre of excellence for the commercialization of medical imaging technologies.

By contrast, the Sarnia-Lambton Campus capitalizes on regional strengths in energy production and has grown to become the country's largest clean tech incubator, focusing predominantly on next-generation biofuels and biomaterials. Its incubator, The Bowman Centre, is home to large, pilot plant facilities that are unique in Canada and allow companies to test new technologies at a commercial scale.

Entrepreneurs, scientists and engineers at the country's research parks and incubators are not only working hard to grow Canada's next generation of biotechnology companies, they are working to improve lives around the world by fighting disease and developing sustainable approaches to food and energy.

JOEL ADAMS

Executive Director The University of Western Ontario Research Park editorial@mediaplanet.com



The power of curement

The sustainability of Canada's healthcare depends in large part on innovations that can enhance the efficiency, safety, quality, and productivity of health and healthcare services.

Biotechnology advances in life sciences offer great promises in this regard. New knowledge and applications in this area are already supporting the production of cheaper and safer drugs and the development of replacement tissues and organs to treat diseases that severely limit the lives of Canadians and impose a high economic burden to our health care system. Moreover, biotechnology is also facilitating a shift towards personalized and preventative medicine, which no doubt will have a great impact on the future burden of disease in Canada.

However, the ability of these innovative treatments and products to improve the health care system and the quality of life of Canadians is directly related to the ability of our health care system to appropriately and timely integrate them into health care services. Therefore, "procurement"—what governments and public institutions buy and how they buy itcan be a powerful tool for driving the development and adoption of innovative biotechnology products and processes. Despite its importance, Conference Board of Canada's recent report, "Innovation Procurement in Health Care: A Compelling **Opportunity for Canada,**" suggests that concepts of innovation and procurement are still poorly connected in Canada. Recent policy papers have highlighted the need for greater innovation at the federal and provincial levels, but the use of the purchasing power of governments has not been emphasized in documents aiming to guide and coordinate health innovation policy or practices.

innovative private procurement by catalysing private demand.

Procurement of innovation:

Used when an innovative product already exists but is not widely adopted driving a need to establish processes to speed up adoption and diffusion.

Through these roles, innovation procurement can improve quality of services and enhance health care system performance while increasing business investments in R&D and economic activity, which drive Canada's competitiveness.

In the U.K., innovation procurement has resulted in significant transformations to the health care system that are driving major improvements. Implementation of the innovation procurement strategy in this country has led to new accountability frameworks and governance structures and the creation of new government divisions and organizations mandated to support the development and uptake of innovative health technologies. The analysis of the successes to date revealed that spurring innovation is cost effective and practical and can have a meaningful impact in a relatively short period of time. not only on people's lives and healthcare but also on businesses and economic competitiveness. This strongly supports the argument that health care can add to our country's growth rather than simply eating into our available tax revenue.

Cultivating Innovation for a Sustainable Tomorrow

The Bioindustrial Innovation Centre is Canada's preeminent accelerator for the commercialization of large scale industrial biotechnology and related sustainable chemistry. BIC is funded through a combination of revenues and investments from the private sector and government, including \$15 million from the Government of Canada's Centre of Excellence for Commercialization and Research Program.

BIOINDUSTRIAL INNOVATION CENTRE Sarnia, Ontario, Canada www.bicsarnia.ca

Dr. Murray McLaughlin **Executive Directo** nurraym@bicsarnia.ca

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What is innovation procurement?

Innovation procurement involves the development of innovations and/ or purchasing of existing innovative products or services to improve the performance and functionality of public services and to solve important socio-economic challenges. Leading OECD countries are increasingly using innovation procurement in three key roles in boosting innovation:

Public procurement of R&D (or pre-commercial procurement):

This is used when there is a perceived need without a commercially available solution. In these cases, procurement becomes a R&D service contract that involves exploration, feasibility, prototyping and commercialization. Innovative procurement: Used to specify a requirement that cannot be met by an off-the-shelf solution but it can be developed within a reasonable period of time. It stimulates

Recognizing a powerful policy tool

In Canada, innovation procurement has yet to be embraced as an effective innovation policy tool.

A survey launched among healthcare executives in Canada. Respondents were almost unanimous in agreeing that innovation is essential for improving organizational performance in the health sector and for the sustainability of Canada's health-care system.

Canadian governments must make stronger efforts to identify health innovation goals; help healthcare administrators and professionals understand their crucial role in driving innovation through procurement; shift the emphasis in procurement practices from cost reduction to value creation; and ensure that administrators and professional staff have the tools and knowledge necessary to support this shift.

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GABRIELA PRADA

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INSPIRATION



Enhancing plant power for sustainable solutions

With the major push today to develop non-food crops that can be used to help produce oil (unlike the extensive use of corn to produce ethanol), Agrisoma Biosciences' timing may be very good. A private agricultural biotechnology company based in Ottawa, it has major field tests under way in six provinces and two states this year on a new feedstock plant—carinata.



with engineered trait loci (ETL), its propriety technology. ETL technology, according to Agri-

ETL technology, according to Agrisoma president and CEO Steve Fabijanski, helps the company get very specific in adapting plant chromosomes to produce maximum crop results—in this case, a plant with enhanced oil content that is tailormade to grow well in semi-arid areas. The initial focus is on very dry areas in southern Saskatchewan and southern Alberta, where carinata is being commercially released next

year.

A side of sustainability

The plant, says Fabijanski, also chair of the agriculture committee of Biotech Canada, was developed from a mustard species that originated in Ethiopia, but which has undergone a significant number of enhancements.

"Previous tests and early results from this year show that carinata does exceedingly well in semi-arid areas," says Fabijanski, who anticipates seeing about 25,000 acres planted in carinata next year. The

Agriculture at the University of Guelph, who has been studying the physiological limitations to productivity of such oilseed crops as soybeans and canola, emphasized that, "We are always trying to develop crops that can grow on marginal land rather than fertile land." While he has not studied Agrisoma's carinata, Earl says the successful development of any such crop would be welcome. "The market has now started to appreciate," says Fabijanski, "that one way to look at replacing oil is to grow it directly."

lant

Renewable fuels in Canada

The effects of agricultural innovation are everywhere—on the kitchen table, in manufacturing, pharmaceuticals, cosmetics, and now in your gas tank with the growth of renewable fuels.

Canadians drive cleaner every day thanks to two federal renewable fuel mandates in place nationwide, including a five percent renewable fuel content in gasoline that came into effect Dec. 15, 2010 and a two percent biodiesel content in diesel and heating oil that began July 1,2011. Many provinces also have their own mandates and programs to encourage the development of the industry.

The benefits of biotechnology on agriculture are perhaps best seen in the dramatic increases in crop yields.Since new varieties were introduced in 1996, Canadian corn yields have increased 33 percent from 112.4 bushels per acre to 156 bushels per acre in 2008. Canola yields rose 50 percent between 1995 and 2010, from 21.8 to 32.5 bushels an acre. These changes come from a combination of advanced plant breeding, biotechnology and improved farm management practices.

Waste not

The relationship between farmers and the renewable fuels industry is an important one. Canadian farmers provide a reliable source of feedstock to producers, and the producers provide good prices and new markets for farmers overloaded with more stock. Biofuels can also be made using the damaged or low-grade crops that are difficult to sell, and ongoing research in the area of advanced biofuels means that one day the primary feed stocks will be non-food products such as wheat straw, corn cobs and forestry residue.

Ethanol and biodiesel have clear benefits for the environment and decidedly positive energy balances. Independent studies have demonstrated that the GHG reduction of traditional ethanol is about 62 per cent, and for biodiesel or cellulosic ethanol it is up to 99 per cent. The renewable fuels mandate alone is equivalent to removing one million cars from the roads.

But this is no rush-to-the-market plant.

Agrisoma started using an advanced version of a proprietary technology about a decade ago. Now, it is getting ready to commercially release carinata, which it developed biotechnology company already has interested farmers ready to plant the crop.

Hugh Earl, an associate professor in the Department of Plant

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INSPIRATION



Question: How can a species of tree bring enormous change to an impoverished region in Kenya? **Answer:** Oilseed initiatives provide renewable energy—and profits to the community.

FUELING THE FUTURE: BEDFORD'S JOURNEY

HOW WE MADE IT

Three years ago in Kenya, the words "Bedford Biofuels" had no meaning for the people of the Tana River region, a long stretch of land in the southeast corner of the country. Today, the company is a household name there—one that symbolizes hope for the people and the planet.

Bedford Biofuels is growing Jatropha curcas on leased land in Kenya to provide biofuel to Africa and beyond. The company was launched in 2008 and now has sales channels in Canada, Asia and the Middle East to fund its biofuel operations in Kenya.

Jatropha is a robust, drought resistant tree, which begins to flower within six to eight months of planting and matures within three to four years. The tree continues to produce non-edible nuts, which contain 34 to 45 percent oil by weight, for up to 50 years.

an American organization that sets worldwide technical standards for the airline and other industries, gave approval for carriers to mix kerosene with non-food plants like Jatropha, and organic waste to power planes.

While Jatropha has been tested for use in aviation since 2008 by Air New Zealand, Continental, Boeing, Japan Airlines, Lufthansa and others, the ASTM approval is a milestone for Jatropha, as is the recent commitment from Aeromexico to use a Jatropha mix for weekly flights between Mexico and Costa Rica. On August 2, the airline successfully flew the world's first transatlantic flight using biofuel with a 70:30 kerosene-Jatropha mix. The flight was from Mexico City to Madrid.

An anticipated need



Powering possibility

Bedford Biofuels' President and CEO, David McClure, sings the praises of Jatropha, not only for its value as a biofuel feedstock, but for what it represents for the 89,000 people on Bedford's leased land in the Tana River region.

"Jatropha has been through years of tests and trials," McClure says. "It has had tens of millions of dollars of research poured into it; NASA has flown it to space to test the impact of zero gravity on its growth, it has properties that can be used in the production of pain killers and other medications, and above all, it produces a clean oil that is superior to fossil fuel—an oil that is not derived from a food crop, but from a non-food biofuel. This is the evolution of biofuel."

As for the impact Jatropha will have on the Tana River region, McClure says Bedford and the locals in Kenya see a bright future together.

"We are reforesting Kenya with Jatropha," he says. "Once this semi-arid land has Jatropha growing on it, the trees will act as carbon sinks. This is a tree that produces non-edible nuts that we harvest twice a year for oil. The trees are planted on underutilized land that has sat idle for generations. We will produce green oil, intercrop our trees with food crop for the local people and provide employment in an area where only five percent of people have work."

Jatropha is a drop-in replacement for diesel, which means its use does not require engine modification. Jatropha oil can be blended for use in automobiles, mining equipment and locomotives, and most recently was certified for use in aircraft. On July 1 of this year, ASTM International,

According to US-based clean-tech analysis firm Pike Research, the total market for renewable jet fuel will reach more than \$100 billion by 2020, requiring the production of more than 30 billion gallons of sustainable fuel per year.

In the spring, Bedford Biofuels received its much anticipated Environmental Impact Assessment license from NEMA (National Environment Management Authority) Kenya and started nursery preparations in late July. The nursery is now teaming with green Jatropha sprouts, which will be transplanted in November.

The backlash

The imminent planting season has the company buzzing, however, the challenges of operating in Kenya have been numerous —some anticipated and others unforeseen. Dustin Mitchell, Managing Director of Bedford Biofuels, said he has been shocked and disappointed by opposition from groups like Nature Kenya, especially in contrast to the support the company has received from Tana River region residents, government officials and organizations like NEMA.

"From the beginning, Bedford Biofuels has been committed to doing everything by the book in Kenya, working with existing groups, meeting all environmental and social interests, and acting in the interest of the people living in the Tana River region," said Mitchell. "We hold regular meetings with the locals who will be affected by our project and they were outraged by the lies some of these groups have been publishing about Bedford.

"These groups have no alternative plan to combat the poverty and poor conditions of the people in the region. They oppose almost all development and have no plan to help the people. They have used the local and international press to spread false information about the project, even though Bedford is widely supported in the duce oil for up PHOTO: S. AZIZ

region by the locals."

He said some groups are claiming Jatropha is not a feasible biofuel feedstock and should be planted only as a fence.

"The lies are just so easy to disprove," said Mitchell. "Planes are flying with Jatropha oil. Jatropha is being grown by 700 farmers in the Tana River region and they are getting oil. Yet these groups claim it doesn't grow. Recent reports claim that two million people in Mozambique use renewable energy, including Jatropha seedcake. Sun Biofuels Mozambique, in fact, just shipped 30 tonnes of Jatropha oil to Europe for evaluation by Lufthansa."

Local support

Mitchell said a meeting of all local stake holders and government officials was called by Bedford to address the false allegations. In spite of the lies and misinformation, local support was overwhelming.

Omara Kalasingha , Chairman of the Kenya Wildlife Forum, the Tana Delta Environmental Management Forum, and the Wildlife Resource Center, said he has the Tana Delta at heart and wants to conserve the wetland, and he supports Bedford's project in Kenya.

"Bedford is not planting in the wetland, they are on the dry land. Bedford also wants to protect the wildlife corridor, as we want to protect the wildlife corridor," said Kalasingha. "This land belongs to the people, and they have given it over to Bedford Biofuels to plant. They support this project going forward.We support this project going forward. The few who oppose this project are not basing their decision on the truth." McClure said he is outraged by the blatant lies being spread by some groups in Kenya, especially when Bedford is essentially a reforestation project.

"Bedford Biofuels is standing up

as the voice of the people who will be employed by us, whose land we are leasing, who have looked me in the eyes and thanked me for offering their children a future," said McClure. "The people of the Tana River region are tired of being misrepresented by those who are robbing them of a future. Their actions are a true crime against humanity."

He said it is criminal that some of the conservation and aid groups are wasting their time spreading lies about Bedford when there is suffering in Northern Kenya, which is experiencing drought and has been flooded by tens of thousands of Somali refugees filling border camps.

"Since getting into this business in 2008, the idea of aid has weighed heavily on my heart," said McClure. "Billions of dollars have been poured into Africa and people are still starving. Aid does not work. We believe in working with local people on viable projects so they can help themselves. The old adage of 'give a man a fish and you feed him for a day, teach a man to fish and you feed him for a lifetime' is so true. We believe in empowering people to help themselves. We are on the ground in Kenya teaching them to fish right now.

"Sustainable energy projects, coupled with humanitarian initiatives, could very well be the solution to the desperation in Sub Sahara Africa. The mentality of some of these narrow-minded organizations has to change, who are deliberately sabotaging the promise of prosperity and stability for the local people."

Bedford, along with its biofuel operation, is bringing its EMPOWER (Every Member Prospers On World Energy Resources) program to Kenya. EMPOWER uses a percentage of the total plantation budget to bring improved housing, health care, clean water, improved education and food security to the region.

McClure said he is forever grateful to the people of the Tana River region for their continued support of Bedford Biofuels, and to the government of Kenya, which has embraced Bedford's vision from the beginning.

Home-grown options

Kenya is one of many countries committed to reducing its dependency on foreign oil by embracing alternative energy.Kenya's Vision 2030 is committed to transform Kenya into a rapidly industrializing middle-income nation by 2030 and supports an alternative energy future. Government mandates around the globe are calling for a reduced carbon footprint to combat global warming.Biofuel is widely seen as the solution to high oil prices due to political instability in the Middle East and an overall increase in energy demand.

According to the September edition of Discover magazine, global investment in clean energy last year was around \$243 billion, with the Chinese leading the investment pack.

McClure said Bedford's sales channels in Canada and Asia are running, and the company is talking to potential joint venture partners during an upcoming road show in Asia.

"Everyone knows the limitless possibilities associated with alternative energy today," he said. "When we talk to investors, they understand our vision and they want to be part of the green revolution, they want Bedford to employ Kenyans so they can help themselves to a better life and a greener planet. That's the business model. That's why Bedford is here No self-serving, malicious groups are going to steal a brighter future from the people of the Tana River region.

GANADA'S BOOMING INDUSTR

A revolution in bio-industrial research and development is afoot, placing Canadian companies and ideas on the front lines of the movement for more sustainable products and processes. Across the country, research teams at academic institutes are looking to make your fuel, food and plastics more earth-friendly.

As the global paradigm shifts towards sustainability, a new generation of innovative chemists and engineers are utilizing "green chemistry," a philosophy of research that encourages the design of products and processes that minimize the use and generation of hazardous substances-to make your life more sustainable.

Researchers at the University of Western Ontario led by Paul Charpentier, a professor and director of Environmentally Friendly Solvents/ Advanced Materials at the Chemical and Biochemical Engineering school, are looking for solutions to the impending peak oil crisis.

global warming or not, oil is going to increase in price as it becomes harder to get at," says Charpentier.

With support from major oil companies, more money has flowed into green energy programs and focus on deriving new fuel sources and even anti-freezes and oils from earth-abundant materials is expanding.

"There's a big push in biomass processing (like) using algae to make fuels," says Charpentier. "There's a lot of interest in that."

Cleaner chemical use

Charpentier notes that the nineties were fuelled by a search for green solvents for industrial use.

"Back then the big push was green solvents," says Charpentier.

Solvents are chemicals used to break down other chemicals.

Because of the high volume of chemicals used by the pharmaceutical industry, the sector became focused on finding more sustainable alternatives to previously used solvents.

"The pharma industry has always "Whether anyone believes in done a lot in green chemistry," says Charpentier pointing out that "one pound of pharmaceuticals generates 1400 pounds of waste."

But although, the pharmaceutical industry has done so much work toward its own waste solutions, Charpentier says the oil and gas industry has taken the lead in bioindustrial research.

Martin Reaney, SMA Chair Of Lipid Quality and Utilization and a researcher at the University of Saskatchewan, says despite the fact that there may not be a lot of money to go around for independent researchers in Canada—where there's a will, there's a way.

"It's a (much) different environment for biofuels than in Europe where they have higher subsidies (for research)," says Reaney. That's allowed green chemists in Canada to become clever.

The age of oilseed

Some of his current research looks at processing the oil from oil cropssuch as soy beans—damaged during transportation on storage.

"Only 40 percent of the oilseed grain

Whether anyone believes in global warming or not, oil is going to increase in price as it becomes harder to get at."

Paul Charpentier

Professor and Director, Environmentally Friendly Solvents' Ad Chemical & Biochemical Engineering school, University of Western Ontario

ends up being biofuel," says Reaney. But utilizing that excess product is where the money lies.

Once processed, the oil can be used as an alternative to petroleum in many cases—from fuel straight through to plastic polymers.

But the connection between biofuels and your food may not be so far removed.

"In all biofuels the biggest energy consumption is nitrogen fertilizer,"

says Reaney. "It's curious-as the price of natural gas goes up the least efficient nitrogen producers get pushed out of the market."

Nitrogen is one of the key building blocks of life and vital to consistent growth of crops regardless of weather conditions.

Manish Raizada, an associate professor and researcher for the department of Plant Agriculture at the University of Guelph, has been focusing on finding cheap and sustainable fertilizers.

One of the keystones to his studies is looking at naturally occurring bacteria as a fertilizer for important crops such as corn (which can later be used to produce ethanol).

"Some of those bacteria will stimulate root growth under conditions where it's really wet," says Raizada "It's very sustainable and it's very cheap."

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Reaching a point of inflection

On the state of the life sciences industry in Canada, PricewaterhouseCoopers described the industry as being at an "Inflection Point."

I too believe that the actions of Steven Kaplan from the University mation in Canada. stakeholders this year will define the Canadian industry for at least the next 10 years. Poised for growth or positioned for failure, the choice is ours. PwC's report highlighted beliefs that raising capital would be the biggest challenge in the next 2 years, and that raising capital would be the key issue for the Canadian industry to overcome if it is to emerge as a global competitor.

to invest in than life sciences or medical technology. Both of these statements are simply not true or anchored by facts or data.

A broken model?

investor and the government agency split the investment return above the threshold rate. Enacted over a finite period of 2 to 3 years, an initiative like this could catalyze over \$1 billion of capital for-





Two challenges/opportunities:

How best to rebuild the venture capital engine in this country.

How to engage the largest corporate beneficiaries of healthcare spending in Canada (big pharmaceutical, biotechnology, and medical device firms) in the innovation economy.

Regarding venture capital, participants at a recent conference on the state of the VC industry in Canada argued that the "VC model is broken" and that information and communication technology ("ICT") is a much better sector

of Chicago's Booth School of Business and Josh Lerner from Harvard Business School refute the notion that the VC model is broken. Perhaps we should strive to better understand the behaviours and structures of the top VC firms around the world, and model those here in Canada before we change the venture capital market.

Lerner cites data that shows that with the exception of the "bubble years" of 1996 to 2000, healthcare investments have outperformed ICT investments. Separate data shows that from 2007 to 2009, in terms of liquidity, M&A exits from venture-backed life science companies have accounted for 42% of cash distributions to limited partners (\$8 billion) despite representing just 26% of all VC dollars invested.

To encourage institutional investment in venture capital funds, the government could offer pension plans, endowments, and trusts a guaranteed rate of return on investments in VC funds, with the caveat that the institutional

To further this country's innovation agenda, we also need to engage more effectively the pharmaceutical, biotechnology, and medical device firms that market and sell products to Canadians. In 1988, the pharmaceutical industry agreed to invest 10% of Canadian sales revenues in R&D in Canada, and the Patent Medicines Pricing Review Board (PMPRB) agency was established. From 1988 to 1997, the R&D to sales ratio for Rx&D member companies grew from 6.5% to 12.9%, and R&D expenditures grew year after year. However, compliance varies between firms. Companies like sanofi-aventis Group and GlaxoSmithKline consistently meet or exceed the 10% threshold, while some other companies invest less than 2% of sales per year. I propose we change the PMPRB guidelines so that direct investments in innovative Canadian pharmaceutical, biotechnology, and medical device companies and VC funds domiciled in Canada that invest in the sector qualify as R&D for measurement purposes.

If so, government could consider strategies that provide favoured formulary access and pricing to compliant firms while subjecting non-complaint firms to price reductions or tax.

The time to act

We are truly at an inflection point. These and other solutions are achievable with leadership, hard work, and a commitment to bettering this country. These strategies have the potential to allow Canada to emerge as the global healthcare leader it is truly positioned to be. Failure to act will result in this country squandering literally billions of taxpayer dollars and immeasurable amounts of human capital. During a dinner I recently attended, a former Prime Minister said "achievement occurs when challenge meets leadership." We clearly have the challenge but do we have the leadership to accept it?

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It's touted for stopping that throat tickle and sinal stuffiness in

its tracks: Consumers reach for Cold-FX to feel better, faster, more than any other cold remedy. The story of the drug's development is just as impressive starting in China at the hands of a scientific whiz kid.

Cold-FX: A wellresearched remed

As a bright, shy young girl with health problems growing up in southern China, Jacqueline Shan was often taken to a herbalist by her grandmother.

"Some of the treatments worked some didn't," she recalls. Her intense curiosity about what was in the treatments, though, helped spark her passion for scientific research.



Faced with virtually no money to advertise Cold-FX, Shan opted for a public relations campaign aimed primarily at the media

ence to announce that the company would be providing Cold-FX to the Canadian Sports Centre in Calgary, which would be encouraging the Olympic athletes training there to take it. And CBC-TV hockey analyst Don Cherry, a Cold-FX user, agreed in 2004 to help promote the product. At the same time, Shan was making speeches to organizations all across Canada.



DON'T MISS!

The healthcare biotech effect

There are few disciplines more aptly suited for the merger between biology and technology then the healthcare industry-and some of the research being done in Canada is at the forefront of this "biotechnology revolution."

The following companies are creating innovative (and in some cases—"space age") solutions to our healthcare woes.

The hot and cold of the matter

VBI Vaccines is an Ottawa-based vaccine development company, focused on developing a formulations technology for storing vaccines at room temperature called thermostabilization.

"Today, most vaccines require storage & shipment at 4-8C, so that requires a heavy investment in infrastructure to keep your vaccines from spoilage," says Adam Buckley, vice president of operations and project management and a co-founder of VBI. "(We're looking to) change the formulation of these vaccines so that they are stable at room temperature."

Ninety percent of vaccines must travel through temperature controlled trucks, planes, warehouses before storage in refrigerators at the final destination, a system commonly referred to as the cold chain.

So why change the traditional methods?

Buckley points to globalization of healthcare-as medicine is exported around the world to regions that may not have access to proper refrigerators or climates that might otherwise damage the vaccines, there's a need to change the way things are done.

Imagine—a world where pharmacists could have storage rooms full of vital vaccines instead of expensive and cramped cooling facilities.

Getting rid of RA

Augurex, an emerging biotechnology that looks to bridge the gap between university research and the clinical use stage has developed a biomarker blood test to help diagnose patients with rheumatoid arthritis (RA). RA is a particularly debilitative form of arthritis that "affects one to two percent of the Canadian population with irreversible joint damage setting in 70 percent of patients within two years of symptom onset if left untreated."

Years later, after earning PhDs on two different continents, she co-discovered Cold FX—now the top-selling cold remedy in Canada.

Early promise

At the age of 15, Shan scored very high on the national tests in China for undergraduate university positions. After graduating, she took the even more challenging national tests for graduate school. Her high marks and growing reputation earned her admission to the prestigious Peking Union Medical College, where she earned a PhD in pharmacology.

During her final year, China began encouraging a number of bright students to also study aboard. The head of her program contacted Dr. Peter Pang at the University of Alberta. A prominent physiologist, Pang arranged for Shan to attend that university and served as her mentor as she went on to earn a PhD.

Research on the go

In 1992, Shan and Pang co-founded CV Technologies on the university's campus. (Pang later died in an automobile accident in China.) After initially doing contract research for large companies, CV Technologies, later renamed Afexa Life Sciences, switched to focusing solely on its own research. Financial challenges ultimately rose and virtually all the staff, including most of the scientists, were laid off within a three-year period starting in 2000. What was left of the company moved out of its rented lab in 2003.That started a nomadic life for the tiny firm, moving from place to place in Edmonton while simultaneously trying to do research and increase income.

A new experiment

In late 2003, Shan, the company's chief scientist, was given an extra role: CEO.

Faced with virtually no money to advertise Cold-FX, Shan opted for a public relations campaign aimed primarily at the media, part of which focused on the scientific research behind the product. One key step was holding a press confer-

Within two years under her leadership, Cold-FX became the number one-selling cold remedy in Canada- and it still is today, according to the July 2,2011 Nielsen Brand Ranking Report. The oncetiny company now has eight labswith 21 PhDs and seven "masters of science" among its staff-at its Edmonton headquarters.

Shan, now in her late 40s, still prefers to be working in a lab to being in the limelight. She has launched a study to determine if Cold-FX can help children recover more quickly from upper respiratory infections.

BOB SPENCE

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The kinder side of tobaccc

Long vilified as a cancer agent, the tobacco plant has been reinvented as a cancer fighter with the potential to dramatically cut manufacturing costs for life-saving therapeutic antibody drugs.

A decade ago, University of Guelph professor J. Christopher Hall, the Canada Research Chair in Recombinant Antibody Technology, recognized the advantages of using tobacco plants to produce antibodies. Tobacco has well-understood genetics, and the ability to grow tall at a rapid pace in a contained greenhouse environment, which bodes well for keeping production and facilities costs low, in contrast to the expensive mammalian or bacterial cell culture systems that produce most recombinant antibody drugs on the market today.

Early on, the Hall research team selected trastuzumab, an antibody that combats HER-2 triggered breast cancer cells, as the first target for their plant-based system.



A powerful purpose

Sold by the Roche Group under the brand name Herceptin, trastuzumab is the drug of choice for an estimated 20 percent of breast cancer cases and made headlines early this year with the announcement that Ontario will provide expanded access to the lifesaving drug.

"Trastuzumab is one of the few cancer drugs that are really effective and have made a difference," says Hall, cofounder and Chief Scientific Officer of PlantForm Corporation, the startup now commercializing the technology platform. "Herceptin costs \$3,200 a vial and the year-long treatment is \$40,000 to \$80,000 so a lot of the antibody is needed. We thought that if we could get our plant expression system to go, it would be useful to society at large."

Mimicking nature

Hall's team went on to successfully produce trastuzumab in plants and has since achieved three key elements needed for commercial viability: a high expression rate, an effective purification system and sugar (glycosylation) patterns similar to those in humans. Classified as a subsequententry biologic (SEB), or biosimilar, PlantForm's trastuzumab is now being tested in animal models with clinical trials to follow.

Herceptin sales were \$5.7 billion in 2010. "The market potential for SEB trastuzumab is estimated at \$2 billion a year by 2016 and \$4 billion to \$5 billion a year by 2019 as Herceptin patents expire around the world," says Don Stewart, president, CEO and cofounder of PlantForm.

Stewart calculates the plant-based system will cut manufacturing costs for antibody drugs by as much as 90 percent. "Patients, health-care providers and insurers all want access to more affordable alternatives to brandname antibody drugs, and this technology will address that demand."

Norma Biln, CEO of Augurex, says with Canada's aging population, it's important to treat the diseases as early as possible to help alleviate the eventual burden on Canadian medicare.

"(The blood test) will help identify more patients with the disease, earlier to ensure that they receive appropriate care and treatment thereby reducing the long-term Medicare expenses associated with the disease," says Biln.

"Canada has many innovations that stem from solid health research that can improve the lives of Canadians while setting the country up for success on the world stage."

Allon Therapeutics

Allon Therapeutics Inc. is also finding solutions for Canada's aging population.

The company is developing neuroprotective compounds derived from naturally occurring proteins in the brain that can help prevent cell death from neurodegenerative diseases such as PSP, frontotemporal dementia, Alzheimer's, Parkinson's, and cognitive impairment associated with schizophrenia.

"In my opinion this is the 'definition' of biotechnology, taking a naturally occurring protein, isolating the most 'active' part of the protein, and synthesizing this peptide fragment to treat disease," says Rick Smith, director of investor relations and communications for Allon.

Allon's drug is currently in the clinical trial stage and biotechnology is clearly influencing healthcare and all of our lives in a necessary and positive way.

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