NON-TRADITIONAL BARLEY BREEDING RESEARCH & COMMERCIALIZATION CONFERENCE

Proceedings

ALBERTA Barley COMMISSION

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Mike Leslie, CEO, Alberta Barley Commission
Welcoming Remarks

The Non-Traditional Barley Breeding Research & Commercialization Conference was organized in direct response to concerns about declines in the crop and livestock industries.

The idea for the conference emerged in March 2009, at the World Barley Malt and Beer conference in Berlin, Germany. While there, Steve Gorst, the president of Canada Malting Co. Ltd. in Calgary, said he thought genetically modified barley for malt was inevitable. At the time, I asked him if he would have to deal with the inevitability or pay more for non-GM product.

A lively discussion followed well into the night with a number of people in the industry. It ended with Doyle Lentz of the North Dakota Barley Council and I deciding to host the first international conference. Doyle and I, plus many of the people who were in Germany that March night, have since had numerous talks about barley and genetic modification. How will it affect yield and quality? How will barley users and their consumers respond? What are the costs and commitments of GM technology? Will GM technology make barley more competitive?

Mike Leslie

This conference is a way to broaden those questions and to open the debate on public funding, private investment (and return on investment), closed/open systems, monitoring and regulations.

The Alberta Barley Commission was pleased to welcome participants and speakers to the conference. Each brought valued insight and perspective to our two-day gathering. For our part, we were honoured to host an event at which speakers and participants could freely and respectfully discuss the many challenges and opportunities of barley production.

We all recognized barley as an integral crop in North America, but one that is, for various reasons, losing market share. Alberta producers recently grew one million tonnes of barley more than could be sold. As well, public research and development funding for barley (and many other crops) has been constantly declining since the 1980s.

To resolve these and other challenges, barley industry stakeholders need to find—in the words of songwriter Don Henley—the cold, hard truth.

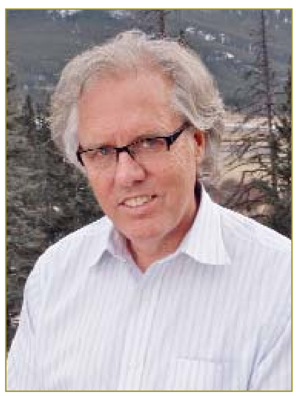
Our organization is pleased to present the key highlights of the Non-Traditional Barley Breeding Research & Commercialization Conference and it looks forward to presenting, sharing and gathering additional information that will help shape the future of the barley industry in Alberta and in barley-growing regions around the world.

Dr. William (Bill) Wilson, North Dakota State University
Keynote Speaker—Looking to the Future

Several years ago, Dr. William Wilson was hired to develop economic feasibility models envisioning the future with and without the Panama Canal. His job was to look 25 years into the future. His team built big models on risk and put 19,000 variables into the model but discovered that only four variables really mattered: China, biotechnology, biofuels and Russia.

Asian countries are now buying wheat from Russia. This will have a huge impact on agriculture in Canada and the United States, which have traditionally considered themselves the bread basket of the world.

Agriculture is in a state of change. Urbanization and increases in income in a number of Asian countries are resulting in irreversible changes in diet, which impacts consumption. At the same time, agriculture is seeing an overall increase in productivity of about 0.8% to 1.3% per year.



Dr. William (Bill) Wilson

This is spawning a wake-up call in the agri-food industry around the world and agriculture is changing rapidly to address these signals. In many ways, the money being invested in research and productivity is focused on this new future state.

What has fundamentally changed in recent years in agriculture:

- A shift in the supply and demand for ethanol and biodiesel
- The rapid development and increased acreage of genetically modified crops
- The policies and regulations around GM crops around the world, most recently in Brazil, where growing GM crops is now legal
- New stacked traits or smart stacks providing improved field performance for GM crops
- Australia's emergence as a leader in GM crop development
- The American Baking Association's stance on GM wheat; its opposition has given way to support for the concept
- Consumer attitudes: they are concerned about food safety far more than GM foods
- China's commercialization drive and need to maintain food security
- A growing lobby by U.S. grain producers for GM wheat and other crops to keep them competitive

Wilson cautions against assuming past consumer attitudes toward GM food will prevail. Producers, researchers and policy-makers cannot cite studies from 1996; they must look forward 10 years and be able to gauge what consumer demand will be then.

In recent studies, Wilson found about 35% of the world market would be averse to GM traits. He predicts the market will have three components: organic, non-GM and GM-accepting. He was recently challenged in Germany, where studies indicate by 2022, Europe will be completely accepting of GM crops. This is reflected in recent acceptance of a GM potato variety in Europe.

Currently in the U.S., about 80% to 85% of foods contain GM ingredients. There, consumers have a high trust of the regulatory system. In Japan and Europe, consumers don't trust the science of their governments' regulatory agents; they want industry to regulate on their behalf.

Another important factor to consider in the development of GM foods is that surveys are a poor predictor of consumer behaviour. Survey respondents often say one thing and do another.

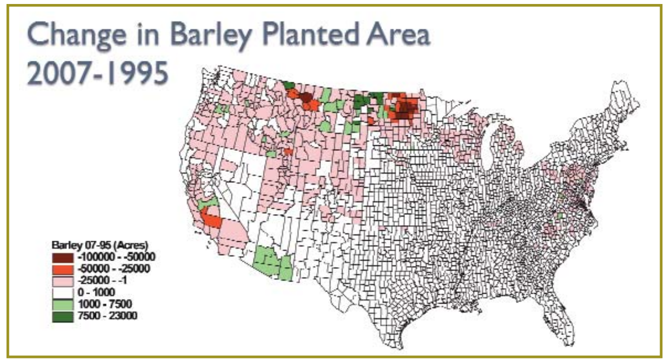
What consumers (in the United States) do care about, in rank order, are:

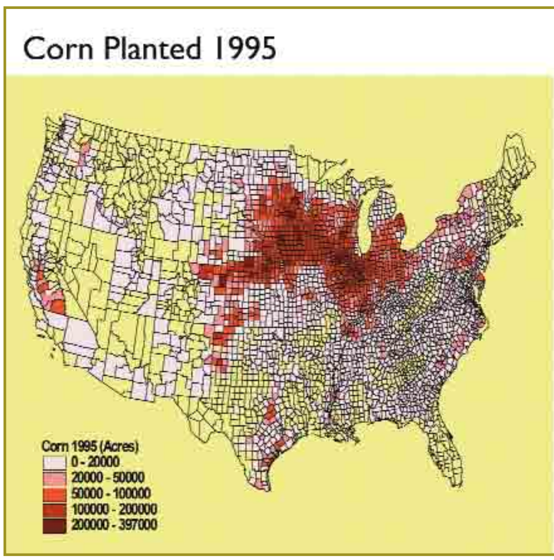
- Sugars and carbohydrates
- Fat, oils and cholesterol
- Animal products
- Salt/sodium
- Artificial flavour and processes
- Spices
- Virtually 0% are concerned about biotech/GM technologies

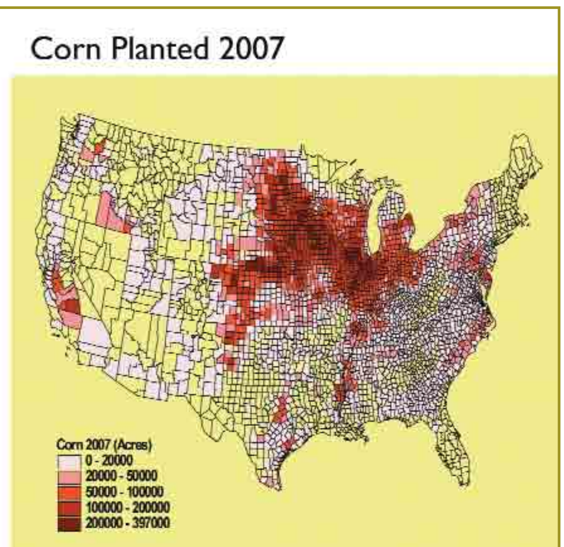
Biotechnology in agriculture has resulted in major changes in growth-rate differentials among and between crops and countries, and, ultimately, shifts in the geography of agricultural production. This change in geography is "very, very, very important."

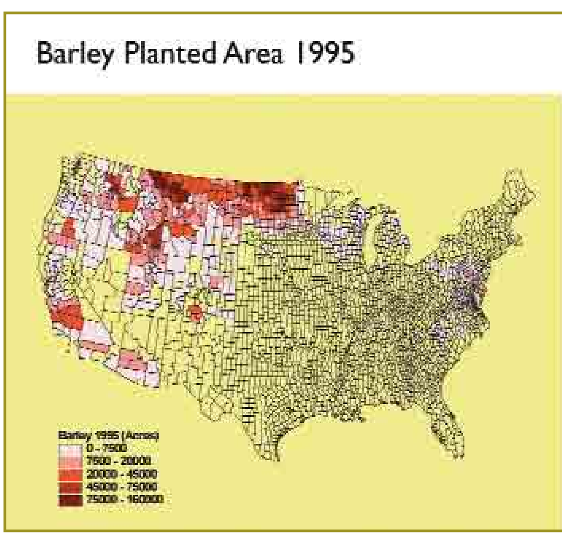
The ready acceptance of GM crops is being driven by economic factors. When the cost of fungicide has gone up 266% and fertilizer prices have gone up 500%, Wilson asks: "Is there any wonder there's a shift to crops such as disease-resistant soybeans with the ability to fix nitrogen?"

Another driving (and serious) factor in agriculture is research funding. Wilson found "a paltry amount of money" is spent on small grain research in the U.S. Much of the industry has become dependent on commodity groups and the U.S. Department of Agriculture (USDA) to spend about 60 cents per acre per year on research. In Canada, research spending is about 40 cents per acre per year. In contrast, industry is spending about $10 per acre per year on GM row crops (soy and corn).

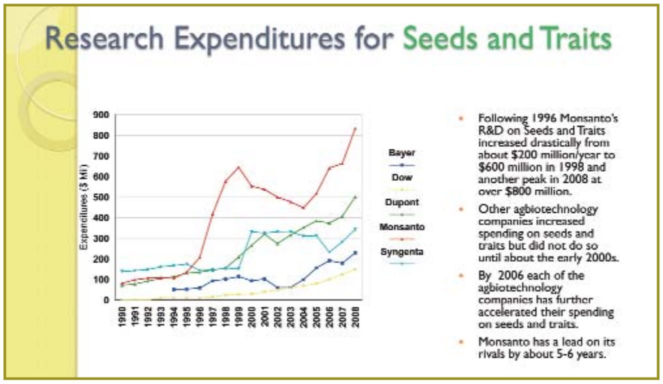






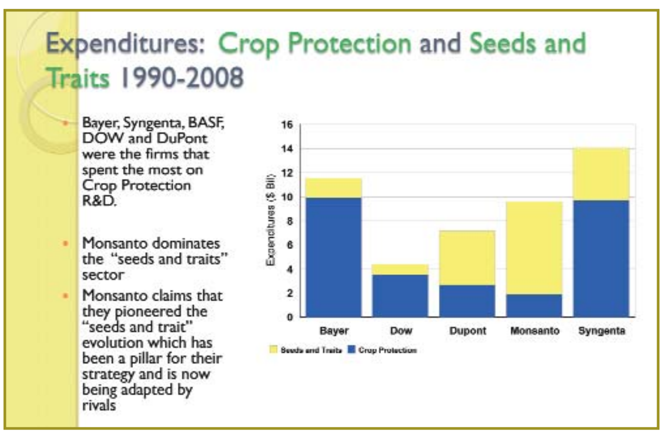


Around 10 years ago, a new industry emerged called "seeds and traits," which combines GM traits with traditional breeding and marker-assisted processes. It's caused a fundamental paradigm shift, particularly in corn and sugar beets.



A combination of producer, processor and consumer targeted traits is being developed. Producer traits have dominated in the past, but won't necessarily in the future.

In many cases, multiple developers are working on these traits, sometimes leading to a more competitive environment, sometimes to a more cooperative one.



Wilson says the USDA views on GM impacts are a continuation of a trend in technological development over time that includes hybrids and better soil testing. The USDA always uses linear trends but this may no longer be relevant.

Beginning in April 2009, Monsanto said it would double yields of corn by 2030 because consumption is going up and the world has to be fed. Monsanto said it would achieve this using conventional breeding technologies and marker-assisted selection, as well as GM technologies.

This will change the world, particularly for crops that don't have comparable technologies.

When one of these technologies, Roundup Ready 2 soybeans, for example, is released, it is expected to increase soybean yields by 7% to 11%. In a farm in the Red River Valley in North Dakota, the opportunity cost to growing wheat will go up by about $1/bushel versus growing the new higher-yielding RR2 soybeans. In other words, it will cost $1 per bushel to grow wheat versus making the extra revenue from growing RR2 soybeans.

The past six months have seen big, new research projects and mergers in GM wheat. Dow acquired Worldwide Wheat in September 2009. Bayer CropScience made a huge research agreement with Cicero, acquired another company for traits, and plans to spend $1 billion worldwide on wheat. Syngenta is developing a second version of fusarium-resistant wheat and recently announced an agreement to develop hybrid wheats.

Added to these players is a cast of new characters. Australia has traditionally been non-GM for wheat, barley and canola, but recently GM canola was deregulated and it is being more widely grown. Attention is now turning to GM wheat and barley for the future.

One of the biggest Australian GM initiatives is in Victoria at the Biosciences Research Centre, where work will include developing drought stress and traits in barley, wheat and other crops. Wilson suspects new lines developed at the centre will be on the market in four to five years.

One of the big questions is which traits will be selected. Wilson recently reviewed a survey that found producer traits were most valuable. Producers said they wanted drought, nitrogen and cold/freeze tolerance traits. Millers wanted yield and kernel quality traits as well as disease resistance. Bakers are most concerned about production traits, such as milling and baking quality.

The bottom line is that, when it costs about $100 million to develop a single GM trait, the resulting crop line needs to be widely adopted. Costs will likely lead to stacking three or four traits to realize the best value for the developer and the producer.

Wilson foresees a battle over different breeding technologies, both traditional and GM.

Public institutions will continue to be strong in traditional breeding and will soon be more involved in marker-assisted breeding but not in a high throughput commercial way. Cost precludes most universities from being involved in GM breeding, particularly when re-regulation costs about $40 million.

Private researchers will dominate GM breeding. Again, cost will be a factor, leading to many explicit and complicit partnerships in the coming months and years.

The U.S. created a joint industry initiative called the Wheat Industry Group Joint Biotech Committee, which involved the (U.S.) National Association of Wheat Growers, the (U.S.) National Agri-Marketing Association and the U.S. Wheat Association. The committee speaks with one voice about the importance of efficiently developing and commercializing GM wheat.

These are things to be looking at because Canada will have to look at the agropolitical process for wheat and direct barley in a similar path.

As a model, Wilson said the sugar beet industry has probably the purest political process in agriculture. It formed the Sugar Beet Biotech Industry Council in 2003 and has since achieved the fastest ever penetration of any GM crop anywhere.

When GM sugar beets were initially considered, end-users misrepresented what consumers would accept. Not one iota of concern has been expressed about Roundup Ready sugar beets (even though in Canada over 95% of the sugar beets harvested are GM).

Wilson sees immense opportunity around GM crops to increase yields and develop traits, although small-acre crops will likely not see the same benefits as large acres are needed to make the investment pay off for the investors in the technology.

In GM barley and wheat development, Wilson sees “institutional barriers.” In the U.S. and in Canada, he foresees misaligned regulations that will inhibit investment in the new technologies.

Dr. William (Bill) W. Wilson received his PhD in agricultural economics from the University of Manitoba in 1980. Since then, he has been a professor at North Dakota State University in Agribusiness and Applied Economics with periodic sabbaticals at Stanford University, teaching commodity trading, risk analysis and agribusiness strategy. Recently, he was named as a University Distinguished Professor at NDSU, an honorary position. In 1995, he was recognized as one of the top 10 agricultural economists.

Dr. Wilson’s focus is risk and strategy as applied to agriculture and agribusiness with a particular focus on marketing, procurement, transportation and logistics, international marketing and competition. He is the co-director of the Center of Excellence in AgBiotechnology at North Dakota State University, working with industry and researchers to increase commercialization of agbiotechnology to crops grown in North Dakota. He has published extensively on topics related to agbiotechnology and works routinely with industry and organizations (including EU Co-existence, Joint Wheat Industry Biotechnology, GMACC, amongst others) on agbiotechnology.

Dr. Wilson led a project for the United States on privatization of the grain marketing system in Russia in the early 1990s. He currently has projects and/or clients in the U.S., Canada, Mexico, Venezuela, Argentina, Brazil, China, Australia and France. He served as a board member of the Minneapolis Grain Exchange for 12 years, on the FGIS Advisory Board, and currently serves as a board member for several regional firms.

Charlie Pearson, Grain Market Analyst
Alberta Agriculture and Rural Development
Survey Results: The Adoption of Transgenic Barley in Alberta

Key stakeholders in the Alberta barley industry recently took part in a study concerning the potential adoption of transgenic barley in the province.

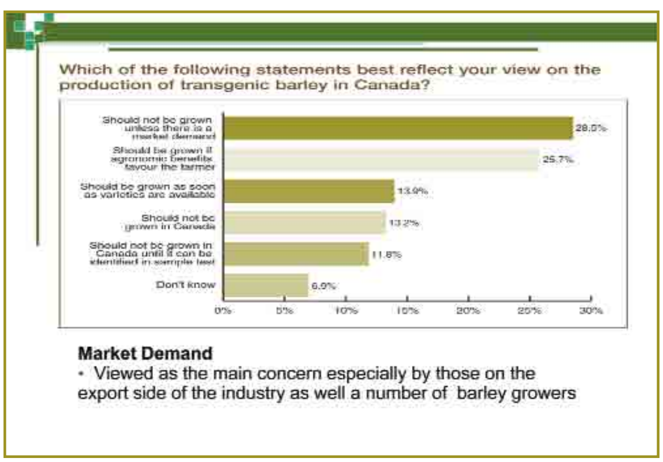
Currently, transgenic barley breeding has not been conducted in Alberta.

The purpose of the study was to develop an in-depth understanding of the barley supply chain's attitudes and perceptions towards genetically engineered barley on their businesses and those of their customers.

Charlie Pearson

The study determined most of the participants had some advanced understanding of biotechnology and plant breeding. Participants indicated they were familiar with terms such as genetically modified organism, transgenic and hybridization.

The majority of those taking part in the study revealed they had some degree of interest in seeing transgenic barley grown in Canada, especially those involved in livestock production. The malting industry and the majority of the brewing industry, however, said they were not at all interested.



The potential to increase barley yield through transgenic breeding technologies was viewed as the main benefit by the majority who responded.

Barley growers, livestock producers and feedlot operators in particular voiced this opinion.

Participants representing the industry's malting, brewing and food sectors indicated they saw no benefits to transgenic barley production.

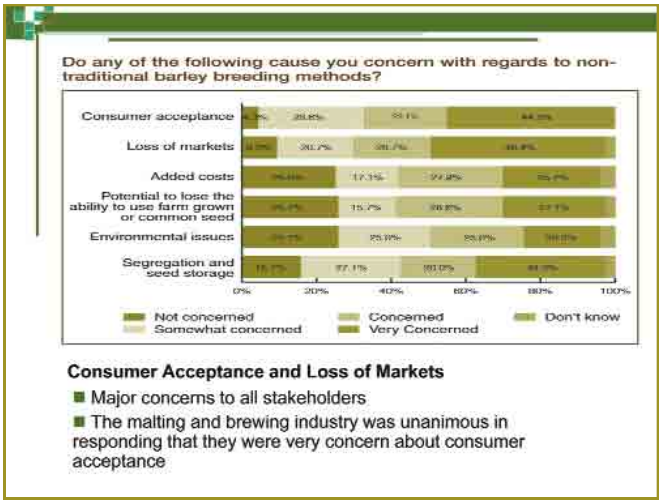
Market demand is a main concern to growers and exporters in the barley industry. If agronomic benefits related to transgenic barley favoured farmers, a number of participants involved in barley production viewed this as favourable.

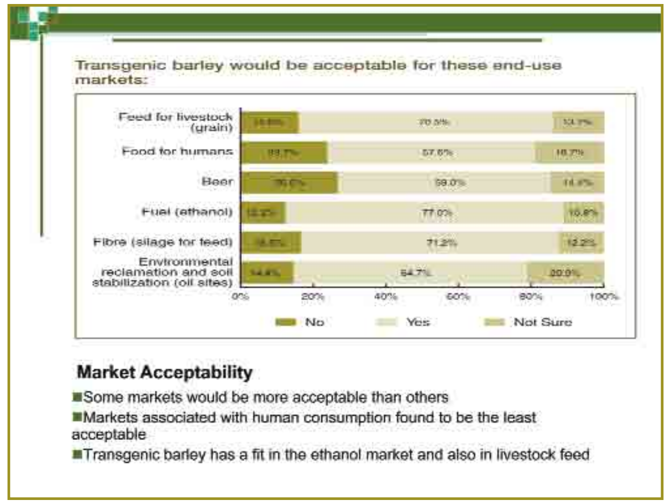
Transgenic breeding technologies vary and the majority of study participants indicated they were most receptive to technology employing a barley plant gene to another barley plant. They were least receptive to breeding technology employing a non-vegetative plant gene and a barley plant.

Consumer acceptance of transgenic barley was the number one concern of study participants, especially those in markets for human consumption (beer, bakery goods, etc.). The loss of markets was also a major concern to the majority of participants (as an awareness of the Triffid Flax incident was playing out at the time of the survey).

Seed segregation and storage was another concern to many stakeholders, including the malting and brewing industry.

In general, study participants indicated some markets are potentially more acceptable for transgenic barley than others. Markets associated with human consumption are the least ready for acceptance. However, many voiced the opinion that transgenic barley could have a place in the ethanol market. And more than two-thirds of participants said it could fit in the livestock feed industry.



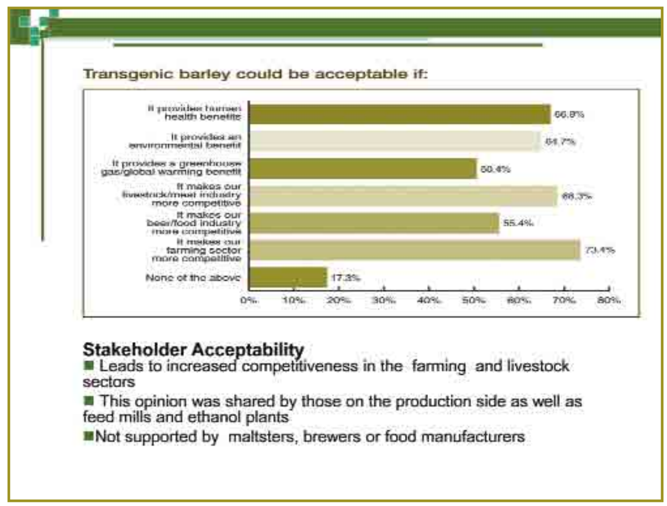


If transgenic barley increased the competitiveness of the barley and livestock sectors, it would potentially be more acceptable, at least to those involved in barley production. If it lowered production costs, and reduced pesticide use, it would be more acceptable.

Participants representing all sectors of the barley industry agreed that if transgenic barley was to be introduced, certain market processes/systems would be needed, especially for export. They strongly indicated the need for an international agreement on tolerances for genetically modified organisms with regard to low-level presence. An identity-preserved system segregating transgenic barley from other barley types would also be needed.

Many participants thought the introduction of transgenic barley would influence the cost of doing business. More than one-third anticipated their operating costs would increase. The malting and brewing industry indicated their costs would rise because of the need for segregation. On the production side, many anticipated seed costs would rise, but could be offset by increased yield and decreased input costs.

And finally, if transgenic breeding technologies were allowed and plant breeders' rights were strengthened, more than half the study's key stakeholders indicated this may make way for multinational seed companies to invest in Alberta. However, many also felt that if this happened, public breeding programs would be negatively affected.



Charlie Pearson is from a mixed farm (grain, registered cattle and hay) southeast of Calgary, which his brother still operates. He has a bachelor of science in agriculture from the University of Alberta and a master's of agricultural economics from the University of Manitoba.

Pearson is currently a member of the Alberta Institute of Agrologists with more than two decades of agricultural experience. He has worked for 13 years with Alberta Agriculture. Prior to that, Pearson worked with the Canadian Wheat Board and United Grain Growers. He was also a private consultant for two years, providing business planning services to farm families. A major focus of these positions has been in using marketing alternatives such as forward pricing in risk management strategies.

Dr. Chengdao Li, Department of Agriculture, Government of Western Australia
Genetic Techniques for the Improvement of Barley Quality

In Western Australia, the malting barley-breeding program is a partnership between the state government of Western Australia, the Grain Research Development Corporation (a national corporation that invests in research and development on behalf of grain growers and the Australian government) and several private companies. The companies include CBH GrainPool, Joe White Maltings, Barrett Burston, Swan Brewery, Matilda Bay Brewery and Kirin Australia.

Dr. Chengdao Li

Barley production in Australia is concentrated in the southern part of the country, with the bulk of production in Western Australia, South Australia, Victoria and New South Wales. The predominant varieties developed through the breeding program are Stirling (which is being phased out), Gairdner, Hamelin, Vlamingh and Baudin (grown on the largest number of acres).

The Australian barley breeding program is organized as a national body under Barley Breeding Australia, which includes west, south and north nodes. The Barley Breeding Australia–West (BBA–West) program consists of a number of different components and techniques to develop new varieties: core breeding unit, germplasm introduction and evaluation, double haploids, marker-assisted selection, quality laboratory, pathology, single seed descent and agronomy/crop physiology.

Double haploid technology (DH) has been used in this program since 1993 and more than 100,000 double haploid lines have been produced. The DH lines account for 25% to 30% of the breeding program and advanced lines are undergoing commercial malting/brewing evaluation prior to possible release.

Anther culturing technology was the main method of production from 1993 to 1998. In 1999, Dr. Chengdao Li and his research team began evaluating potentially more productive methods, such as microspore culturing. Today both methods are used in the program.

Li has also studied the potential of space-induced plant mutation. Space offers a distinct environment: strong cosmic radiation, microgravity and weak geomagnetic field. It is also a supervacuum and superclean.

These conditions, scientists believe, may change the genetic makeup of seeds and may affect chromosomal aberrations when seeds are germinated back on earth. Results are not yet available.

BBA–West's molecular plant breeding component has three parts:

- Discover new markers/genes that associate with key agronomic traits
- Implement and validate marker-trait combinations in wheat and barley programs
- Establish new technologies in order to increase the scale of diagnostics available for assaying variation in breeding programs.

Molecular plant breeding has three aims:

- Adding value to breeding programs
- Reducing the cost of introducing specific traits into barley and wheat varieties
- Developing varieties with better combinations of traits

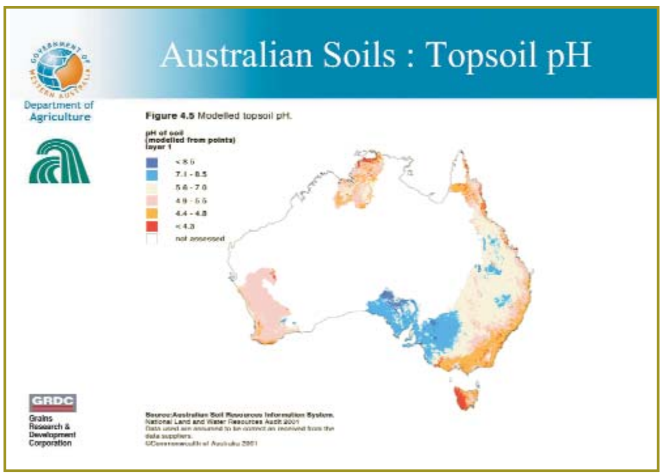
The process uses four main steps:

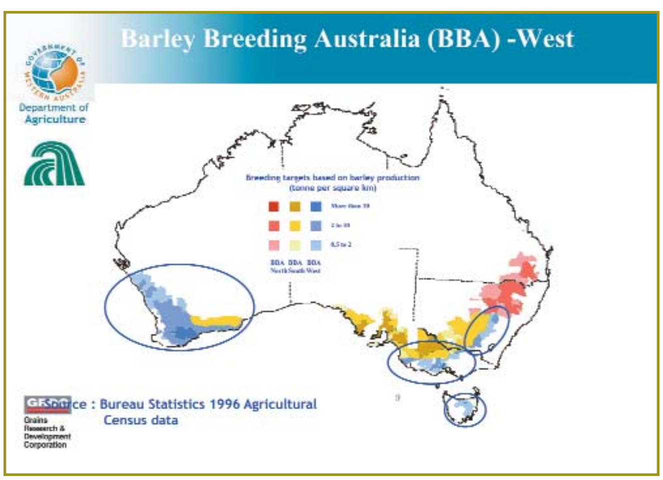
1. Basic research identifies candidate genes and linked markers
2. Molecular markers are identified
3. Molecular markers are implemented
4. Discrepancies in implementing molecular markers are identified and re-validated.

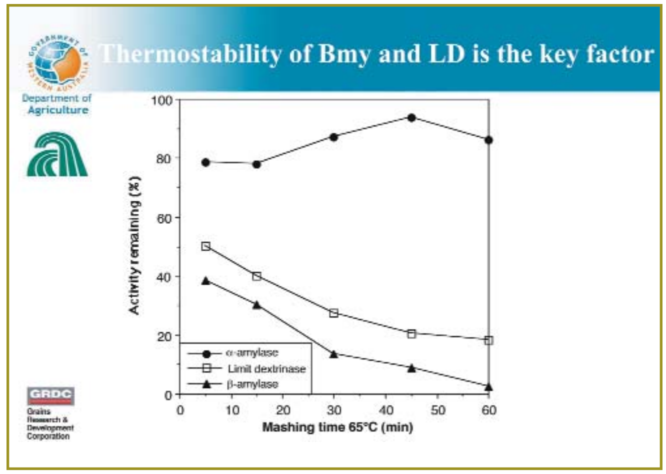
Marker-assisted selection has been integrated into the barley breeding program to enrich breeding populations for target traits (backcrossing, top-crossing and intercrossing). It is also used to improve the genetic gain of the double haploid program (pre- and post-double haploid screening), reduce the cycle time and modify conventional breeding, whole-genome screening and variety identification.

Through BBA–West, molecular markers have been implemented for more than 20 different traits/loci, including alpha-amylase, beta-amylase, limit dextrinase, boron toxicity, frost, acidic soil, leaf rust (Rph3 & Rph7), photoperiod response and powdery mildew (ml09 & 11 and Mla). Others include scald, net-form and spot-form net blotch, barley yellow dwarf virus, loose smut, malt extract, diastic power, seed dormancy/pre-harvest sprouting and kernel discoloration.

Soil acidity with high levels of toxic aluminium is the largest (in area) soil constraint limiting sustainable crop production in Australia. Barley is the most sensitive cereal crop to acid soils. Molecular markers were developed and implemented in the breeding program. After three years of crossing and marker-assisted selection, an acid-resistant variety was yielding over 90% of the current number one 1 variety Baudin on acid soils.







Li and his researchers further improved breeding efficiency by combining marker-assisted selection with RIPE (recurrent introgression for population enrichment).

The BBA–West has come a long way in order to catch up to the malting quality of Canadian malting barley varieties, especially when comparing Australian varieties such as Stirling to Canadian varieties such as Harrington. The new malting barley variety Baudin from the BBA–West is similar to the leading Canadian malting barley variety, AC Metcalfe.

Li is confidant Australia's barley breeding industry will meet the future challenge for malting quality.

Variety	HWE	DP	AA	MD	Vis	KI	BG	AAL	FAAN	LD
Harrington	6	7	7	7	6	7	8	7	6	8
Stirling	4	7	4	4	4	4	3	5	4	4

1: poor quality; 9: excellent quality

Dr. Chengdao Li is a principal molecular geneticist and breeder for barley in the Department of Agriculture & Food for the Government of Western Australia. He is also an adjunct professor at Murdoch University in Australia and the Zhejiang University of China. Dr. Li is one of the breeders for barley varieties Baudin, Vlamingh, Hamelin, Roe, Hannan and Lockyer. Baudin has excellent malting quality and is the number one malting barley variety in Western Australia.

Dr Li's research focuses on improving barley breeding efficiency by the integration of molecular marker assisted selection, doubled haploid, mutation and conventional breeding. He received his master's degree in plant genetics and breeding from Zhejiang University in China and a PhD on plant molecular genetics from University of Adelaide in Australia. Dr. Li has also completed three years of postdoctoral research at the University of Saskatchewan in Canada. He has been a barley breeder in China for eight years and is widely connected to the Chinese malting barley industry and research community.

Amélie Genty, Secobra Recherches, France
Speeding the Release of New Barley Varieties

Releasing new varieties of barley is important, says Amélie Genty, because as soon as a variety is registered every breeder can use the findings in their program. In some cases, competitors can actually get to market faster than the original developer.

Genty has completely changed Secobra's breeding program. In the past, the company used a classical program to do plant research. Today, it uses double haploid technology and greenhouses, saving up to three years of development time.

Amélie Genty

Before explaining the process, Genty presented an overview of her company, which was founded in 1902 as a union of brewers. This is also why the company remains involved in the malting chain. Secobra is now privately held, mainly by a number of maltsters and brewers.

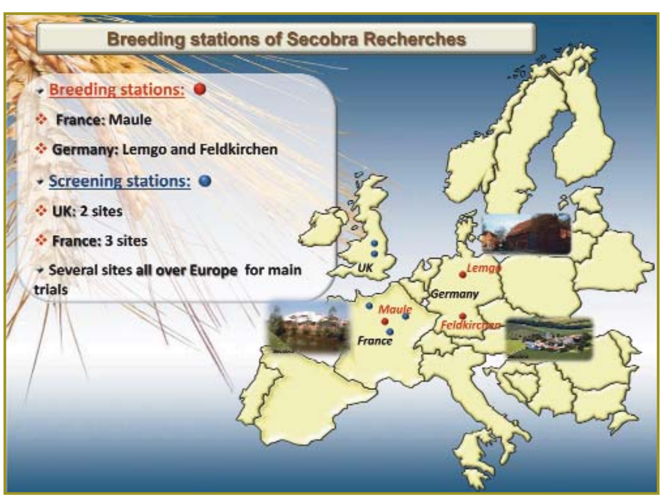
Secobra breeds two- and six-row malting-quality winter barley and spring barley varieties.

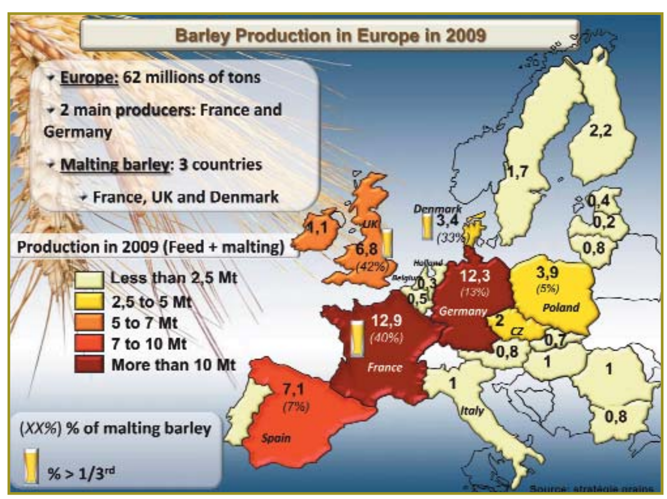
The company operates one station in France and two stations in Germany, plus a number of screening areas throughout the UK and Europe.

Europe is the world's top barley producer; in some areas of France, yields reach 10 tonnes per hectare (180 bushels per acre). Winter barley yields an average of five tonnes to 10 tonnes per hectare (95 to 180 bushels per acre). In France, malting quality barley is about 40% of the crop and in Germany it's about 13% of the crop.

The main malting barley producing countries in the European Union are France, the United Kingdom and Denmark. Winter barley is grown mainly in central Europe; eastern Europe grows mainly two-row barley and France and Germany grow six-row barley.

Genty now screens her test crops closer to the actual growing areas to ensure the varieties are suited to local conditions.





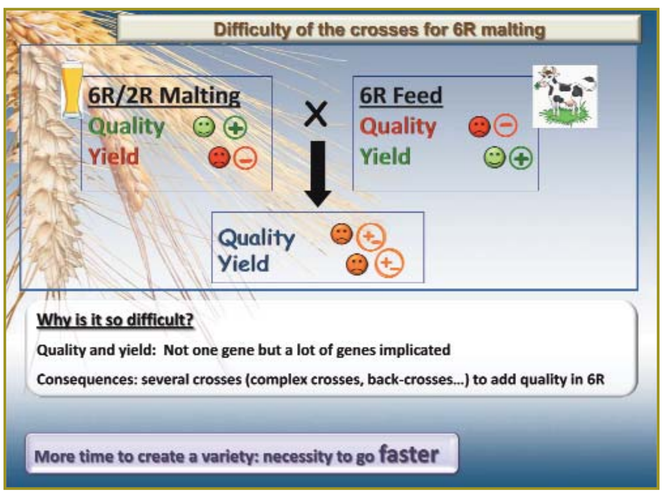
Six-row barley is grown in France for a number of reasons. It has higher yields, meaning higher revenues for producers and lower costs for brewers and maltsters. Six-row also has an earlier harvest, starting at the end of June or, at the latest, the beginning of July.

Many farmers plant alfalfa and rapeseed right after their barley harvest, making for a good rotation. In Europe, winter barley also provides winter cover to protect from soil and water erosion.

The reason winter barley is not as widely grown in France and Germany is that, until recently, few malting varieties were available. The crop was planted in October and harvested in June, making it impossible to grow more than one crop a year. For this reason, it was not possible to speed the breeding program.

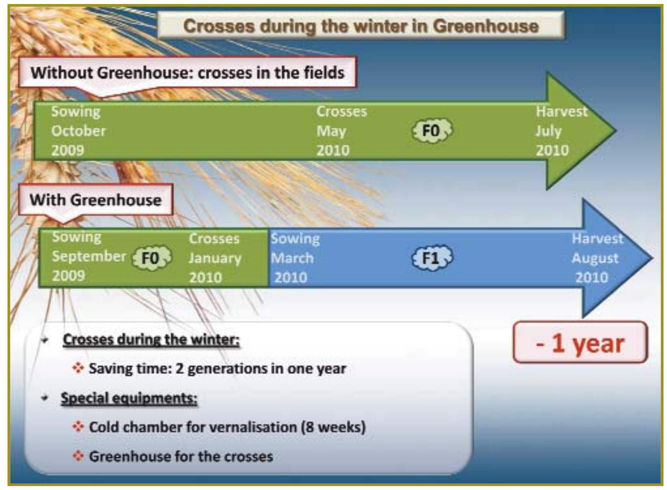
It has been difficult to breed winter barley for malting barley because the gene pool was very narrow, although that's changing.

The solution to breeding a good winter malting barley is not simply to cross a spring malting variety to a winter feed variety because of the number of genes implicated in quality.



The answer is complex crosses. Genty has crossed six-row winter barley with two-row winter barley and even spring barley to breed for quality. Due to the complexity of the crosses, it takes time to develop new varieties, so she must do everything faster.

The old breeding program took nine to 10 years. Using double haploid technology, Genty conducts crosses during the winter in the greenhouse, when technicians have time for this activity and can sow several times to extend the seeding period. Sowing in the greenhouses means the research team does not have to depend on the weather.



Without the greenhouses, the cross could only take place once a year (in May) in the field. With the greenhouses, crosses can been sown in December and re-sown in March, resulting in two generations in one year (and saving a year of time). She then multiplies the outcomes and tests the results from these speeded varieties in the field.

Double haploid (DH) quality evaluation is performed at Secobra's lab, making it easier to control the predictions and crosses. The process is conducted in winter and usually results in a good reproduction of DH prediction.

Genty's program today is 100% DH, producing at least 30,000 samples per year. Further efficiency is gained by using molecular markers and keeping only the good mother plants.

In order to speed the research process, Genty tests as soon as possible. Although she wants the research period to be shorter, she does not want to lose good, reliable data in the materials evaluated. In winter barley, she does not measure for quality until the fall, because the grain has considerable dormancy, as is required for good malt.

Secobra also has a micro-processing unit in-house, which gives the research team a better understanding of the variety's characteristics and produces initial results within a week (outside tests can take months).

In the future, Secobra will continue to work on six-row winter malting barley because quality can be achieved and it fits with the producers' needs for two crops per year.

In changing her research approach, Genty felt it was important to control the volumes and generate reliable data at a reasonable cost.

While Genty has reduced development to six (from nine or more years), she does not believe it can be reduced further.

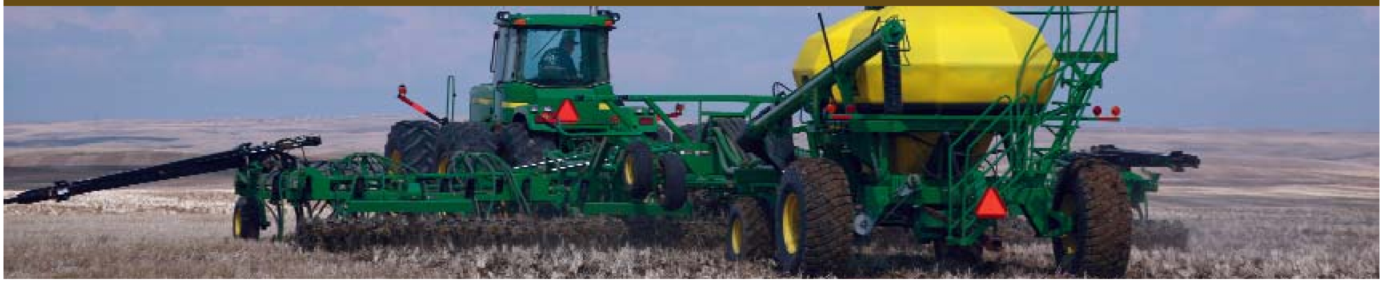
Still, she is working to be more efficient. For quality analysis, she would like to have a better characterization of the lines in early generations.

For Genty, molecular markers are a tool, but only a tool, for improving the breeding program. She still needs to have good field experimentation.

Ms. Amélie Genty is a winter feed barley breeder with Secobra Recherches in France. Ms. Genty graduated from INA-PG, France's top post-graduate engineering school for life sciences. She specialized in genetics and crop improvement. During her studies, she completed several internships with breeding companies and institutes. One of them took place at the Malting Barley Breeding Department of the University of Saskatchewan.

Since graduating three years ago, Ms. Genty has been working as a barley breeder at Secobra Recherches, a breeding company working on wheat, spring barley and winter barley. Secobra has a strong experience in malting varieties and is closely linked with maltsters and brewers, as some of them are shareholders. Secobra is the leading company for malting barley varieties in Europe.

The main part of the winter barley breeding program is dedicated to malting quality, both 6-row and 2-row. To be very efficient, the winter barley program is 100% DHs.



Dr. Jaswinder Singh, Department of Plant Science, McGill University
Enhancement of Barley Using Genomic Tools

Dr. Jaswinder Singh's presentation reflected the promise and complexities of genomic-assisted plant breeding. He and other scientists around the world are devising new molecular strategies to understand the function of every gene in barley and other cereal crops.

The major thrust of his work is to enhance barley's quality, quantity and its unique features through the identification of its genes. Because barley (Hordeum vulgare) is diploid, it is a better genetic material to study than other important cereals such as wheat. Its seven cytologically distinct chromosomes are homoeologous to wheat chromosomes.

Functional genomic activities take place at three levels: DNA (in which genes are stored), gene expression (during which genes are transcribed and translated) and metabolomics (where genes are "set" through biochemical circuitry and phenotypes). Of course, genetic activity can also be affected by environment, drugs and diseases.

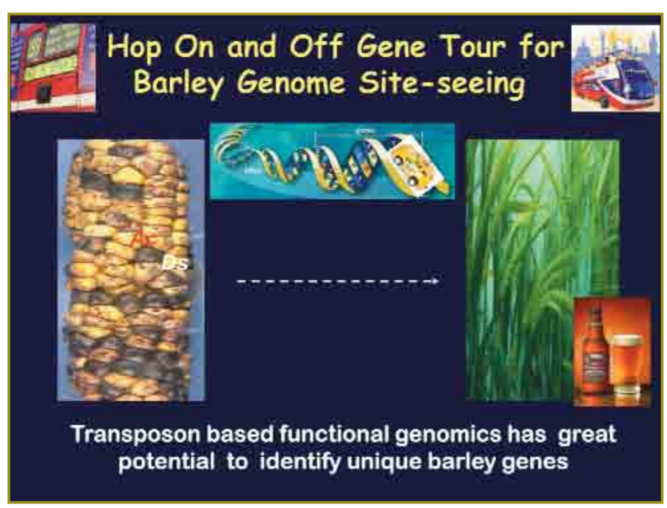
Dr. Jaswinder Singh

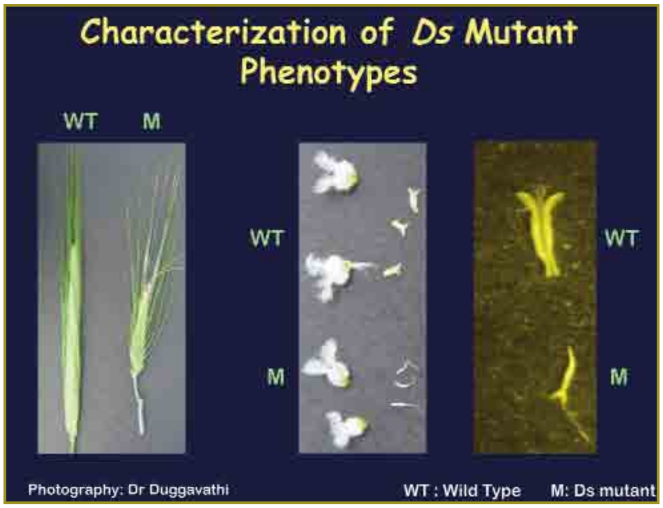
Sequencing will be helpful in understanding genetics, but it cannot solve all the questions. Singh has spent much of his career trying to solve some of these questions.

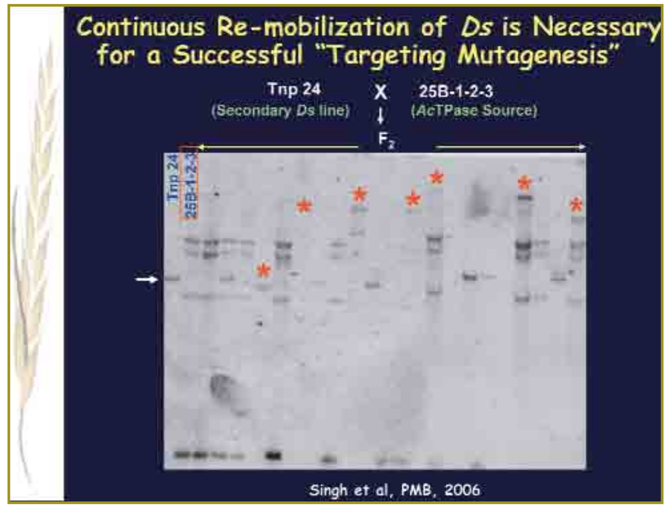
At the DNA level and the protein level, the differences can be seen but at the biological level, the phenotype level, breeders want to know what the genes are controlling.

Many different approaches are being used to determine gene function, such as the transposon system, activation, inactivation, mutation and double standard RNAi.

Singh's laboratory at McGill University has been using naturally occurring transposon systems to delineate the barley genome. The new method uses so-called "jumping genes" to launch new genes around the genome and is valuable for creating new varieties of cereal crops in a manner that is rapid, safe and less work-intensive than many other methods.







Plant breeders are interested in these transposable elements in barley because the barley genome is large and complex, meaning it's a good gene search engine. Singh says he wants to "drive on the barley genome during a 'hop on and off gene tour' and see what's useful." He believes devising transposon-based strategies for gene identification and function holds great promise.

The main idea is to introduce transposon in each gene, which can be achieved in two ways. First, generate and study large populations containing transposon insertions, which is valuable but takes considerable time and money; second, integrate the transposon system with already existing genetic maps to dissect important chromosomal regions.

The major objective is to generate sufficient stable lines of barley transposable elements (Ac/Ds) and to assign one line to each barley bin. The bins are the divisions of barley chromosomes through mapping.

The next steps involve:

- The molecular characterization of Ds insertion lines
- The localization of Ds elements on barley chromosomes
- Exploring the biology of Ds reactivation
- Expediting functional genomics studies in barley and other cereals.

Singh and other scientists have been able to identify the location of several malting barley qualities on chromosomes and see this as an important step in understanding how the traits can be controlled. They have also been able to determine the chromosomal regions influencing up to 39% of beta-glucan concentration.

In summary, Singh concluded the transposon system is highly functional in barley for gene tagging and, when combined with mapping, will help plant breeders with functional markers in addition to helping them understand the function of important genes in cereals crops. Singh believes that transposon technology is an improved system that can play an important role for transgenic gene delivery in cereal crops that addresses some of the difficult issues raised by other gene introduction technologies.

Dr. Jaswinder Singh is an assistant professor in the Department of Plant Science at McGill University. Dr. Singh's research efforts focus on the enhancement of cereal crops with the aid of modern genomics tools. He has a unique blend of skills in molecular biology, biochemistry, genetics, and plant breeding, refined with the new tools of genomics, proteomics and genetic engineering. His broad skills in plant science allow him to integrate new methodologies with conventional methods to make his efforts more efficient and practical.

Dr. Singh received his PhD from the University of Sydney in Australia in 2000 after completing his graduate research at CSIRO Plant Industry, Canberra. During his graduate studies, he developed comprehensive protein maps of wheat grain proteins and generated a library of monoclonal antibodies for the development of high throughput ELISA-based markers for future cereals improvements.

He did his postdoctoral studies at the University of California Berkley in the United States where he standardized transposon-mediated gene discovery tools in barley. Prior to this, he worked as a plant breeder at Punjab Agricultural University in Ludhiana, India and developed several high yielding, disease-resistant and drought-tolerant wheat and triticale elite progenies.

Dr. Singh has published over 24 research papers in high impact journals that include PLoS Genetics, Plant Physiology, Plant Molecular Biology, Molecular Genetics and Genomics, Plant Biotechnology Journal and Journal of Cereal Science. He currently serves as advisory board member for an international journal and a reviewer for various national and international granting agencies including NSERC, AAFC and BARD.

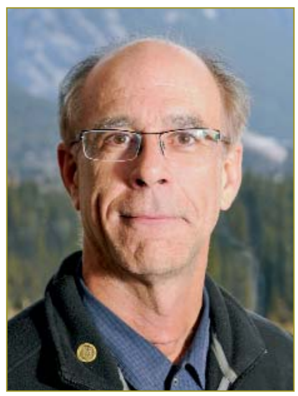
Dr. Allen Good, Department of Biological Sciences, University of Alberta
International Initiative on Nitrogen Use Efficiency

The “easy” biotech transitions in agriculture have already been made: herbicide tolerance and insect tolerance.

This has led to thinking that the next generation of biotech would be similarly easy. Those in the field now appreciate that it’s not going to be that simple.

In his presentation, Dr. Allen Good stressed second-generation traits will be much more complex because scientists are working with plant physiology. The challenges and incremental changes will be in areas plant breeders have struggled with for many years.

A dozen years ago, no company was interested in nitrogen use efficiency. Subsequent to that, nitrogen fertilizer prices soared. As well, the effects of fertilizer use on the environment are starting to be recognized. Worldwide, hypoxic dead zones are emerging, the largest being in the Mississippi Delta/Gulf of Mexico. Fertilizer runoff is having a significant effect on marine and aquatic ecosystems.



Dr. Allen Good

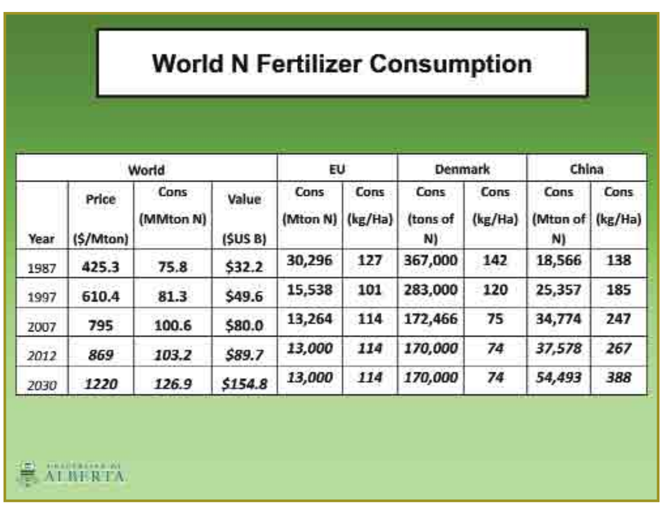
The nitrogen market is widespread and large: about 100 million tonnes of nitrogen-based fertilizers are sold for $80 billion to $100 billion annually. And consumption and costs are rising; by 2030, an estimated 127 million tonnes will be sold for $155 billion annually.

While consumption in China is skyrocketing, in the European Union consumption has been halved in recent years. This is the result of regulated consumption management projects that have significant penalties and social pressures.

Yet the Europeans are not seeing yield losses and are producing up to 12 tonnes per hectare (220 bushel per acre) in ideal conditions.

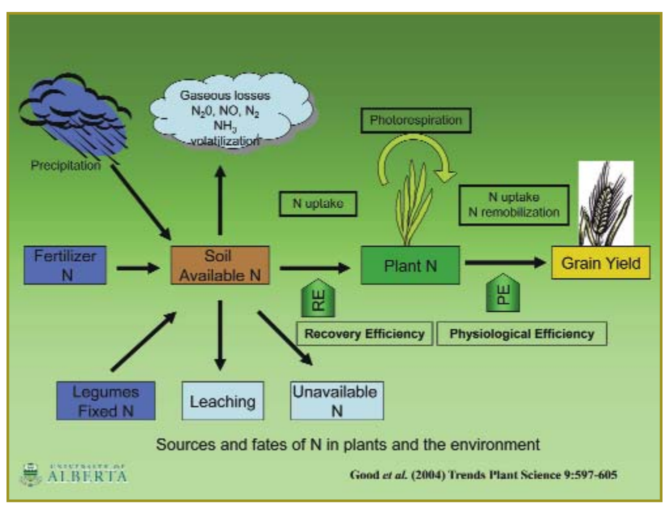
Producers worldwide can grow crops with far less fertilizer and continue to maintain yields.

Good has helped put together an international initiative around nitrogen use efficiency. One of the ideas being addressed is the notion of having plants fix their own nitrogen. Although he doesn’t see this happening in his



World N Fertilizer Consumption

	World			EU		Denmark		China	
Year	Price ($/Mton)	Cons (MMton N)	Value ($US B)	Cons (Mton N)	Cons (kg/Ha)	Cons (tons of N)	Cons (kg/Ha)	Cons (Mton of N)	Cons (kg/Ha)
1987	425.3	75.8	$32.2	30,296	127	367,000	142	18,566	138
1997	610.4	81.3	$49.6	15,538	101	283,000	120	25,357	185
2007	795	100.6	$80.0	13,264	114	172,466	75	34,774	247
2012	*869*	*103.2*	*$89.7*	*13,000*	*114*	*170,000*	*74*	*37,578*	*267*
2030	*1220*	*126.9*	*$154.8*	*13,000*	*114*	*170,000*	*74*	*54,493*	*388*



career, he sees the potential in the future. For now, he and other scientists are focused on making plants harvest nitrogen as efficiently as possible.

If nitrogen use can be made efficient, yields could increase and the actual amount of nitrogen required may decrease.

From a biological perspective, the challenge is that fertilizer must be applied in a certain time window. In addition, nitrogen leaches out into the environment and producers are competing with microbes and having nitrogen volatize to the air. Most estimates put nitrogen uptake in plants at 30%, so losses are about 70%. If plants could capture up to 50% or 60%, then yield increases or fertilizer reduction savings could be significant.

Good and his research team produced a nitrogen-efficient canola variety under low N conditions, which has since been tested in the United States. At the moment, however, there's no intention to release a commercial variety with this trait.

Since then, the trait (which was originally cloned from barley) has been incorporated into wheat, corn, rice, turf grass, sugar beets and barley. To date, almost no data is available on the efficacy of these varieties.

Increasingly, Good and colleague Steven Rothstein think choosing the right promoter—rather than "slamming in" a gene into a plant—will be the right scientific choice.

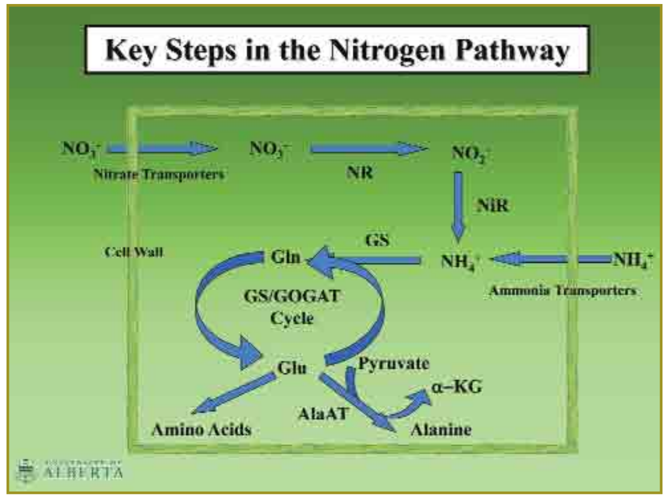
Through the international initiative they established, Good and Rothstein are now looking at forming a public/private partnership with a number of companies. They will focus on long-term basic research to get the technology into the field and onto the market.

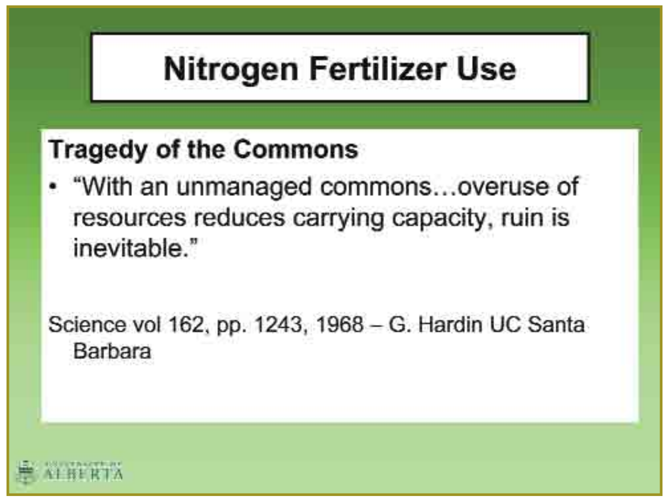
They are particularly interested in forming a patent pool, in which members can share and benefit from patents. This model has been used for sewing machines, aircraft, radios, MPEG 2 compression technology, cellphones and DVDs.

Good is confident this model will work since even private companies have limited resources or do not always have a mandate to conduct such research. While public sector researchers are regarded as disorganized, they do have the ability to provide a more dedicated focus over a longer period of time. Public researchers tend to have a longer "corporate memory."

Nitrogen is an interesting chemical because, unlike phosphate and potassium, it is abundant and readily available. (Most of the air we breathe is nitrogen.) Nitrogen can also be easily converted into nitrates relatively cheaply. But it has been overused, in many ways to a gross extent.

There's no question ruin is inevitable if nitrogen use does not become more efficient.





Finally, Good sees a fundamental problem with researcher funding. While he would be the first to support more basic research funding by scientists pursuing their own interests, he also strongly believes a focus and new models are needed to achieve the necessary results.

Dr. Allen Good obtained a PhD in genetics from the University of Ottawa in 1986 and worked as a post-doctoral researcher at the Plant Biotechnology Institute/National Research Council in Saskatoon. In 1989, he accepted a faculty position in the Department of Genetics at the University of Alberta; he continues to work there today. Dr. Good's main research interests are in the genetics of crop improvement, specifically within Brassica and safflower, and the molecular biology of stress tolerance and nutrient use efficiency in crop plants. He was the developer of one of the key technologies currently being evaluated to improve nitrogen use efficiency in plants.

Dr. Good was the founder and CSO of AgriGenomics Inc. and has worked with a number of different companies, including Arcadia Biosciences, Pioneer HiBred, SemBioSys Genetics and Syngenta Biotechnology. His business interests include the efficient use of genetics and genomics for plant improvement, specifically nitrogen use efficiency, and the development of effective strategies for improving and advancing the interactions between research scientists and product development teams.

Panel Discussion #1
Private and Public Breeders Look Forward—Opportunities and Challenges in Barley Breeding

Participants

Dave Dzisiak, Dow AgroSciences Canada

Dr. Jim Helm, Alberta Field Crop Development Centre

Charles Pick, DNA LandMarks

Dr. Jim Radtke, Cibus U.S. LLC

Dr. Brian Rossnagel, Crop Development Centre, University of Saskatchewan

Dave Dzisiak

In the past 10 years, Dow's breeders have made significant advances in canola and sunflower to create value. Creating value is a matter of capturing value to the benefit of everyone in a value chain.

In the last year, Dow has started to turn its attention to cereal grains, mainly wheat, but with an eye on barley and oats.

Capitalizing on biotechnology opportunities has involved understanding consumer and societal attitudes and trends. The world's population is growing and agricultural production must increase by 50% by 2030. Coronary disease, often the result of lifestyle choices, costs Americans $100 billion a year. Agriculture can't change what people eat, but it can make what people eat healthier.

This creates an opportunity to put traits and characteristics into crops that have never before been contemplated.

It begins with a focus and a mission. The pace of science is going to be phenomenal and biotech is not over, it's just starting. But biotech is not the only solution. Science is moving so fast scientists are doing things they didn't dream of five years ago, such as non-GM tools to regulate genes, up-regulated genes and turning genes on and off. The ability to manipulate gene function, without using transgenics, is a critical capability to create opportunity.

The barley sector needs to create a high-gross margin to compete with canola and wheat. One advantage in Canada is storing crops on-farm and shipping them as needed. To be able to segregate and identity preserve is a huge advantage for Canadian agriculture.

Understanding how a new variety will work will create more opportunities in the value chain. The challenges are finding the funds and people to invest in barley in addition to understanding intellectual property and demonstrating research value.

Jim Helm

Some of the "new" technologies have been around for 50 or 60 years, what's new is how they're being used.

Understanding the genetics and agronomics of crops is very important. Scientists need to better understand how genes respond and work in different environments. New technology could help us gain this understanding of genes, gene combinations and gene responses when moved from one environment to the other.

A better and faster model for phenotyping needs to be developed, such as one for pyramiding disease-resistant genes.

Another possible advance could be screening for quality and phenotyping with technology such as that used in medical diagnosis and NIR (Near Infra-red Spectroscopy). NIR could be used throughout agriculture to look for phenotypes, nutritional (and anti-nutritional) factors and allergens.

Challenges include integrating agronomics, pathology and quality into an economically marketable package. Plus the cost: up to $100 million to put one event into one crop. This doesn't include putting a trait into a high-yielding variety.

Costs will drive partnerships; the public system cannot spend $100 million to put one trait into a variety. Government, growers, end-users and the breeders, pathologists, molecular geneticists, cereal scientists and nutritionists all have to work together. This has not been the case in the past.

The Barley Development Council meets every two years and looks at the priorities for research in barley. We also list all the different people with research projects.

Panelists Dr. Jim Helm and Dave Dzisiak.

Charles Pick

From a genomics standpoint, this is a time of unbelievable development. Not long ago, the sector was talking about genotyping for $2 a data point; today it costs about $.003 per data point. Sequencing was the same. The original cost of sequencing the human genome was $3 billion. Soon it will be less than $1,000. That technology is not just trickling down to agriculture—it's flooding down. The challenge right now is keeping up with the data.

Not long ago, sequencing for barley was inconceivable. Today, 4,000 SNPs (single nucleotide polymorphisms) have been mapped and tens of thousands of markers are available. These are excellent tools for dissecting traits of interest for analysis.

If GM technology is ever used in commercial barley production, these markers could be used to move transgenes from one elite line to another very quickly and rapidly.

The sense is the next generation of traits is going to be largely endogenous to the species and highly complex. They'll be difficult to clone and move around as has been done with single-traits and even stacked traits. They will require much more sophisticated methods that can only be delivered with genomics.

This is not merely conjecture: at the large ag-biotech companies, investment in genetics is almost in line with investment in GM technology.

The challenges . . . Trait complexity: "When we didn't know much we thought we knew everything—and we thought when we knew the sequences of genes that's all we'd need to know," Pick said.

Plant breeders now know it's much more complex. They're finding expression levels are very important, especially in traits dealing with yield and stress tolerance. And they're learning more about the factors affecting expression.

It's not going to be as easy as once thought. Fortunately, the tools are being developed to help.

One of the bigger questions is: If you're going to invest all this money, how are you going to get it back? So much is invested in corn because it has the greatest economic significance of any crop out there. In developing new breeds, the barley industry needs to understand how value can be captured throughout the value chain and how identity can be preserved as the grain passes through multiple hands.

The public continues to have a negative view of GM technologies and that crosses over to genomics. DNA LandMarks' parent company, BASF, was recently the first company in Europe in well over 10 years to receive approval on a transgenic potato. The approval was only gained after BASF sued the government to sign off on the product.

It's still a very tough battle.

Dr. Brian Rossnagel

There is nothing wrong with genetically modified material, no matter how you produce it. Mankind has been doing it for many generations, particularly in the past century.

Every time a plant breeder goes to make a cross, it's the same as producing children—it's a genetic experiment.

Scientists have seen tremendous gains in their knowledge of the barley genome and this is increasing annually. One of the problems is that so few people are working on barley and they can't possibly keep up with all the information available. This is true of many other smaller crops as well.

A huge potential exists in barley research and development, with growing interest from new players. With this, however, comes the need to generate profits and paybacks.

Some people seem to be afraid of profit for private industry, but Rossnagel said it's one of the most valuable things the country can have because it creates jobs and better quality of life for everyone. This does create the need to generate margins "for this new hand in the pie."

Regarding biotech solutions for stress tolerance such as drought, Rossnagel challenged the implication that at some point farmers will be able to grow crops essentially without water because of biotechnology.

“That is absolute bio-bull——,” Rossnagel charged, “and it will not occur.”

In the canola industry, public germplasm was utilized and industry has gained tremendous profit. At the time, no one saw the value of the germplasm; the fact is if someone had suggested private companies should pay for it, the companies likely would have agreed. This is now a possibility and public germplasm should be given its proper value.

Keep in mind the realities of Western Canada—which is not Iowa and does not have an essentially unlimited growing season or excess moisture. The margins here don’t lend themselves to the same revenues as growing corn in the U.S.

Research and development costs will grow. The anti-GM movement has taken away the ability for public breeders and smaller private breeders to use this tremendous technology. Only the biggest companies can afford take on the risk of R&D in today’s international regulatory and intellectual property systems.

Major impediments in this country include the Canadian Food Inspection Agency’s plant novel trait regulations and the lack of a Canadian definition for GMs. This has to be sorted out.

Another drawback is that barley is very recalcitrant when it comes to the basic types of science needed to use biotechnology. This, unfortunately, make it more expensive to work with.

Panelists Dr. Jim Radtke and Dr. Brian Rossnagel.

Dr. Jim Radtke

Understanding more about the structure and function of genes is extremely important. As more is learned about the relationship, that information can be used with newly developed technologies to make traits that are desired by the barley breeding community.

Question from the floor: Jim Downy from Secan.

Earlier, someone mentioned that not much is known about barley sequences, but more is known about other crops. Genomic information collected from other crops can be utilized in barley to build the understanding of what barley genes potentially do.

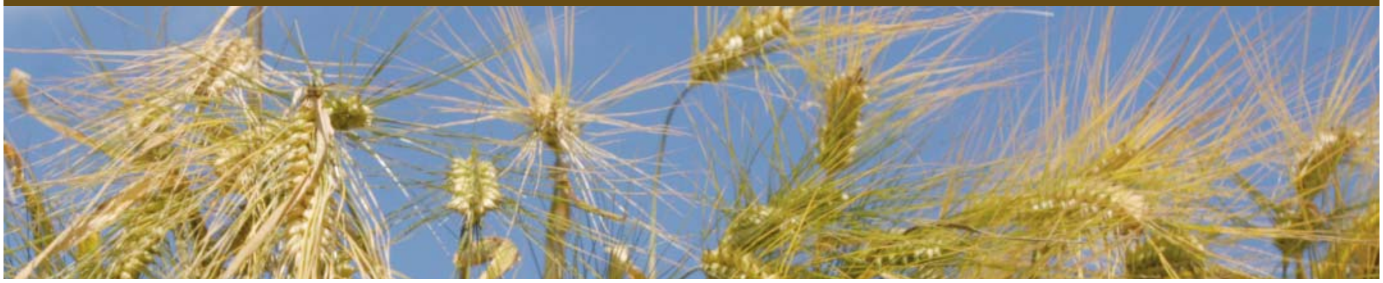
Radtke’s second point was on technology, specifically RTDS, a proprietary technology owned by Cibus that takes advantage of naturally occurring mismatched repair enzymes in the plant to change DNA a single base at a time to affect the phenotyping and improve the crop.

His third point was on the ability to use this technology to convert genes in commercial barley to look like those in their wild relatives. He explains that this can create a quick breeding bridge and possibly keep valuable traits that are already in the commercial barley without the typical linkage drag associated with classical breeding and introgression from wild species.

Dedicated funding is needed to carry a project through to the end, typically for a number of years.

Proper technology is also needed. Non-transgenic technologies such as conventional breeding, genetic markers and double haploids can come together to create breeding technologies that can be used without excessive regulatory burden.

New varieties must create value that is obvious to the producers, which will result in greater demand and increased barley acres.



Panel Discussion #2
Barley Customers—Opportunities and Challenges in the Marketplace

Participants

Michael Brophy, Brewing and Malting Barley Research Institute

Jay Burrows, Western Feedlots

Dustin Gosnell, Canadian Wheat Board

Dr. Richard Joy, Rahr Malting Canada, Ltd.

Brad Fournier, Alberta Livestock and Meat Agency

Michael Brophy

One of the opportunities for the Canadian barley industry is its world-class breeding programs and world-class breeders. Both are recognized around the world.

While some of the country's leading breeders have signalled their intention to retire in coming years, the reality is their institutions have world-class reputations and have been using biotechnology to complement traditional breeding programs.

Canada can build on this opportunity. The barley industry has already achieved success with traditional breeding programs using biotechnology processes such as molecular marker-assisted selection and double haploid technology.

Another opportunity exists with the strong relationships between end-use companies and plant breeders. Added to this, the BMBRI and other industry stakeholders assist in determining what the marketplace really needs.

Canada's barley industry has also had success with new varieties that have provided productivity gains to both growers and maltsters. More are in the pipeline, some with improved productivity and characteristics for maltsters and brewers.

Canada has a good system of public and private institutions; the check-off dollars from farmers are private money. Farmers are business people investing in the industry.

In terms of challenges, the BMBRI has GM and transgenic barley on its agenda. Some customer resistance exists, and time will tell if it changes. The BMBRI supports more research and development in this area.

Another challenge, also shared by the Barley Development Council, is the need for an effective detection and segregation system if GM varieties are developed. As well, proof is needed to show that GM or transgenic techniques actually provide successes traditional techniques cannot.

While seemingly minor, definitions are a challenge. For example, the definitions from the Canadian Food Inspection Agency are very broad and transgenic could mean the moving of genes from one barley plant to another barley plant using traditional techniques or using genetic engineering techniques. Common definitions as to what is or is not GM or transgenic are needed not just in Canada, but around the world. This could eliminate some of the misunderstanding and fear.

Although public/private funding was mentioned as a benefit, it's also a challenge because government funding of breeding programs is decreasing.

Something else to consider is what if new GM or transgenic varieties are developed and they're only equal to the existing varieties? Will farmers grow them and will maltsters and brewers want them if there is no major economic gain or advantage versus non-GM varieties?

It's likely traits will have to be stacked to generate benefits in yield for farmers and benefits in quality for maltsters and brewers. That applies for both traditional and non-traditional breeding.

Jay Burrows

From the lot feeders' standpoint, one of the main opportunities is the potential for cattle feeders to work with the plant breeders, although both still need to learn more about each other.

Currently in the feedlot industry, everything is measured by cost of gain. The Canadian industry operates in a commodity beef environment and barley must compete with U.S. corn as a feedstock.

Panelists Jay Burrows and Michael Brophy.

The industry needs to look at energy costs as well as future consumer trends, such as nutrient profiles and components and carcass performance profiles, along with secondary feeding benefits such as low bloat and starch breakdown.

Cattle feeders need to provide such information to barley breeders. With this comes the challenge that cattle feeders have to determine what they want—it's no small task. Anecdotally, it may appear feeders want higher yields but is that in fact all they need?

New varieties require significant animal trials in conjunction with the plant breeding. Such studies will have to consider the nutritional and carcass impacts that could be associated with new varieties.

There seems to be little incentive in Western Canada to expand on barley's potential. Look at the trend production acres, not necessarily the yields. If anyone has any question as to whether this is the truth, just look at the Western Barley Futures Contract. It has 26 open interests, down from more than 18,000 a few years ago.

In conclusion, some of the substantial challenges ahead are compounded by the tectonic shift in cattle feeding. For example, cattle production in the Texas Panhandle, southern Colorado, New Mexico and the high plains feeding area has been moving into the Midwest corn belt. The same could happen in Canada. Nonetheless, this could be an opportunity for the cattle feeding industry to improve.

Dustin Gosnell

Gosnell clarified a misconception that the Canadian Wheat Board is anti-biotechnology. Despite an issue with wheat a few years ago, the CWB is not going to be standing in the way of development, although it has certain important considerations to meet prior to commercialization. The market has to be ready for GM wheat.

The CWB acknowledges non-traditional breeding and that both it and traditional breeding can bring benefits to the marketplace.

The most critical elements in non-traditional breeding for wheat and barley are the significant investments companies face. Clear indications of the limits (and limitations) of investment are needed. If companies feel Canada has barriers to investment, that must be dealt with. From an exporter's perspective, being able to market varieties customers are interested in will go a long way to achieving at least some market acceptance.

Market acceptance is critical. Contrary to other comments made at the conference, Gosnell believes in 10 and 20 years some customers will still want non-GM products.

Current regulations around the world for zero tolerance on unapproved events make it unfeasible to trade non-GM products. A good example is what happened to flax when one errant seed in 10,000 disrupted the entire Canadian industry.

Question from the floor: Charlie Pearson of Alberta Agriculture and Rural Development.

As long as tolerance levels are reasonable, segregation is feasible, although costly. Costs will be dependent on how tight the tolerances are.

In a CWB survey with wheat and barley producers in the spring of 2009, 54% of respondents said they did not see acceptance in their markets now or in the near future. When asked if a 5% discount would help, 46% still said no. When asked if their customers would be willing to pay a premium on non-GM products, respondents overwhelmingly said no.

Richard Joy

Maltsters see an opportunity for potential qualities developed through traditional and non-traditional breeding. For example, a substantial increase in extract, malt quality, improved agronomics and disease resistance.

Adopting new breeding technology is a good opportunity for the grain industry to teach the public about advances in agricultural production. The acceptance of GM in the malt industry must come from consumers.

Maltsters are somewhat "frozen in time because our position is we can't have a position on a position," Joy said.

Processor acceptance of GM technology comes down consumer acceptance, which comes down to consumers saying: Do I want GM beer?

Still to be determined is whether GM barley will cause allergen concerns.

Education and awareness are a huge challenge and misinformation is out there all the time. The barley industry needs to nip that in the bud as soon as possible.

Another challenge is who will put up the dollars and who will ride these costs until it's accepted? We're waiting for signals: will the consumer accept it? If they do, maltsters will, too.

Panelist Brad Fournier of Alberta Livestock and Meat Agency.

Brad Fournier

The Alberta Livestock and Meat Agency is making a significant investment in livestock feeding and grain breeding, most recently through an $8-million initiative to advance livestock feeding.

The question remains: "What is the barley industry's position in the midst of that?"

Fantastic transfer platforms exist to transform barley and help it catch up to corn and hybrid production.

Sadly, during the past 10 years in the feeding industry, barley has not competed well against corn. Not only is corn cheaper than barley, but it has also made considerable gains in productivity.

Fournier pointed out that no one was outraged when Amélie Genty talked about producing cheaper malting barley. He wants to see dramatically cheaper feed prices for Alberta's livestock feeding sector.

Question from the floor: Doyle Lentz from the North Dakota Barley Council.

New varieties developed abroad could possibly be brought to Alberta; little incentive exists to make that happen.

The good news is barley really does have a place. ALMA has been to Japan and heard consumers there prefer a white-fat beef product, which comes from barley. For decades, Alberta beef has been synonymous with barley-fed beef.

ALMA wants to grow and expand markets like Japan's, whose consumers are willing to pay more for Alberta beef. The key is: will enough barley be produced here? Alternatively, maybe supply chains can be used specifically for such markets.

The livestock sector is finally waking up to technology such as NIR. Dr. Helm has provided profound leadership in this area. The next step is industry adaptation.

A challenge exists with Canada's multiple breeding programs and their hundreds of projects. Despite the number of projects, relatively few are related to developing new feed, forage and industry varieties of barley.

Alberta's agricultural community has had to adapt to corn and DDGs. Canada produces a million-and-a-half tonnes of DDGs and imports another million tonnes a year.

The barley industry needs to know the average profitability for a feedlot over 20 years is zero. Feeders are constantly looking for ways to keep operating for another year.

Widespread changes are needed for the livestock industry to be profitable and sustainable. Now is the time for private/public partnerships. Those collaborations have to be Western Canadian or even North American focused. Leadership needs to be consolidated and be supportive of Alberta's livestock sector.

NON-TRADITIONAL BARLEY BREEDING RESEARCH & COMMERCIALIZATION CONFERENCE

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