



Flax Genomics: Impact on You as a Producer

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What is Genomics ?

- *“In the next 20 to 30 years, Genomics will be what the internet was in the past three decades.” (Dr. Henry Friesen)*



What is Genomics ?

- *Involves looking at the DNA of a living organism and identifying genes and their products (RNA, proteins and other metabolites).*
- *For example, the human genome contains around 40 ,000 genes and over 250,000 proteins.*
- *Once the genes have been identified, the work begins to discover their function (e.g. World Wide Knock Out Mouse Project); proteomics is the study of the proteins derived from these genes and their function.*



Interesting Facts About Genomics

- *Unless you are an identical twin, your genome is different from that of every other person who has ever lived.*
- *Almost all (99.9%) of nucleotide bases (building blocks of DNA) are exactly the same in all people; but the 0.1% difference determines if we are susceptible to a range of infectious diseases and hereditary diseases. Consider there is only 0.1% difference between you and Einstein!!*
- *We share 98% of our DNA with chimpanzees; 90% with mice; 21% with worms; and 7% with bacteria such as E.coli.*



More about DNA

- *DNA is made up of four different building blocks (nucleotides – that are bases and are abbreviated by the first letter of the name i.e. A, T, G and C.*
- *About 3 billion pairs of bases that are arranged along chromosomes in a particular order for each individual. It is twisted in the shape of a double helix.*
- *A strip of DNA is coded like this: ATCATTGCCAA*
- *It would take a person typing 60 words per minute, eight hours a day, around 50 years to type the human genome.*
- *In the next 60 seconds your body will produce enough new DNA that if it was linked together would stretch 100,000 kilometers*



Why Should We Study Genomics?

- *Genomics can be applied to most industrial sectors – agriculture, forestry, environment, human health and fisheries.*
- *It can be applied to help develop better crops, reduce environmental stress, improve water quality, prevent and treat disease.*



Why Should We Study Genomics?

- *Discoveries will transform health care and result in new approaches to research, new ways to diagnose disease and new ways to prevent disease.*
- *Dr. Bernie Juurlink of the U of S says we are in the third era of nutrition research:*
 - *Importance of carbohydrates, fats and proteins in our diet;*
 - *Trace elements and vitamins and how they are essential for enzymes that controlling our metabolism;*
 - *How compounds we eat affect specific gene expression. E.g. berries such as blueberries can turn on certain genes that may reduce the incidence of chemically-induced cancers*



GENOMICS ON THE PRAIRIE



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Applications of Genomics

- *Researchers in the Prairies have made recent discoveries that have significant potential to mitigate agricultural losses.*
 - *Dr. Gusta at U of S discovered a gene that he has put into canola, flax and potatoes crops that has shortened growth cycle, increased yield and resistance to stresses.*
 - *Dr. Rob Hill at the U of M and his colleagues have identified a plant hemoglobin that resists damage from flooding – a huge asset to Manitoba.*



Frost-Tolerant Wheat...

Crop losses due to frost damage were estimated to be >\$0.5 Billion during 2003-2004

Project leader: Dr. Brian Fowler
Total value: \$8.1 M
Genome Canada's contribution: \$4.1

- Saskhardy#8
- Improved grain quality for livestock feeds and malting barely for export
- Lower risk of crop failure
- Flexibility in Management choices
- Sustainable production systems:
 - Less herbicide
 - Less energy expenditure
 - Better moisture utilization
- Cropping alternatives for growers
- Applications to frozen foods



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*Canola's
economic
impact:
\$3 B/yr*

Designer Oils...

Project leaders: Randall Weselake, U Alberta
Wilf Keller, PBI
Total value: \$ 15.8 M
Genome Canada's contribution: \$ 6.8 M

- Leading vegetable oil, in 70% of vegetable oil products in Canada
- Using genomics approaches to develop:
 - Better processing characteristics
 - Higher oil yield
 - Animal feed market opportunities
 - Healthier oils
 - Environmentally friendlier industrial oils



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Genomics and Flax

- Genomics research in flax involves the identification of all the genes in the flax genome and the identification of the function of these genes
- PBI has started a project to sequence to flax genome
- This research has many applications and benefits
- For example, genes can be found that may impact
 - disease protection,
 - easier processing characteristics,
 - healthier oils,
 - industrial oils,
 - fibre characteristics,
 - additional nutritional characteristics
 - accelerated plant breeding.



Accelerated Flax Breeding

- By isolating specific genes and employing different techniques, the breeder can breed the desirable traits into plants faster. These include several non-GMO breeding methods such as
 - haploidy (growing the plant from a pollen grain),
 - molecular markers (bookmarks which let the breeder know where the genes for a specific trait are located so that they can breed more of the desirable traits, and less of the undesirable traits).
- tilling (finding specific genes using specific probes)



Example of Use of Genes in Breeding

- Researchers from Bioriginal and the University of Saskatchewan have identified a gene mutation that is responsible for the production of high linoleic acid in flax (Dr. Xiao Qiu, Dr. Gordon Rowland et al)
- The presence of this gene can be identified in early stages of plant development to accelerate the screening and selection of desired flax plants.



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Genetic Engineering

- Genomics can also be used to create GM varieties of flax
- For example, a company in the US has announced its plan to produce EPA and DHA in a transgenic variety.
- A recent publication has suggested that there are technical problems in using flax for these products; there appears to be a bottleneck in the plant that limits production of the long chain fatty acids
- This technical problem has caused researchers to consider other host crops for these Omega 3 fatty



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Genetic Engineering & Flax

- While there may be companies quietly working away at transgenic flax (this is difficult to know), there appears to be a trend to use non-food crops as a host plant for industrial products in transgenic plants .
- For example, an international consortium including the Chinese, Europeans, Americans, Australians and Canadians is looking at crambe as a host crop for producing wax esters



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ISSUES Re: GM Flax

- There are 2 sides to the GM flax issue
- Negative
 - Risk of losing markets for existing flax varieties, especially Europe
 - Fear of contamination
 - Uncertainty re: containment systems and
- Positive
 - Loss of potential market opportunities for products to other crops.
 - Inability to compete with other crops re: price and environmental stress
 - Reduced investment in flax research



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Options for GM Crops

- A number of suggestions and strategies have been and continue to be evaluated by industry, academia and producers
- Banning of GM flax production
- Development of improved containment technologies
- Improved IP systems – e.g. organic productions requires strict separation of materials; lessons can be learned from these systems
- Use of morphological differentiation for GM flax; ie. Different coloured seeds and flowers
- GELS research – work with the research community to develop research programs to research and address legal, environmental and ethical issues



GM Flax – the Future

- The choices we make about this important issue will impact the Flax Community for many years to come; Therefore;
 - This is a decision that should not be made lightly and should be made based on the best impartial information
 - All aspects of the impact must be considered
 - Involvement of all stakeholders



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