Innovation in the Livestock Industry

Prepared for

The Canadian Biotechnology Advisory Committee
Project Steering Committee on Intellectual Property and the
Patenting of Higher Life Forms

By

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INNOVATION IN THE LIVESTOCK INDUSTRY

Prepared for

Intellectual Property/Patenting of Higher Life Forms Project Steering Committee
Canadian Biotechnology Advisory Committee

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Executive Summary

The Canadian livestock genetics industry is a large and diverse industry that incorporates many participants, both large and small and contributes significantly to the profitability and competitiveness of the Canadian livestock industry. The industry is characterized by many breeders and breeding companies that can access diverse genetic resources from large populations of livestock. The focus of the livestock genetics industry has traditionally been production of food for domestic and export markets. This has required that livestock genetics focus on many traits that are economically important to the respective industries. The Canadian industry and its associated research and development support have been leaders in the development of innovative technologies to enhance genetic evaluation and genetic improvement programs. Canada is regarded as a world-leader in genetic evaluation technology development. These technologies have been shared and exported to many other livestock genetic industries around the world. Implementation of these technologies together with the various partners in the industry has resulted in world-class national genetic improvement programs.

Technology development and innovation have entered a new era with the development of intellectual property rights, licensing agreements, royalty payments, etc. Traditionally Canadian breeders protected their genetics by limiting access outside the country and developing genetic improvement programs that ensured continual genetic improvement that resulted in an enhanced competitive position of the Canadian industry. The basis of this industry was a cooperative focus among Canadian breeders that included access to genetic resources, exchange of genetic material and direct access to technology developments. New developments resulting from industry consolidation, biotechnology and molecular genetics have the potential to create significant distortion in the Canadian livestock genetics industry. The most critical issue will be access to technological developments for the Canadian industry. The relatively small size and cooperative nature of the Canadian industry puts it at a significant disadvantage when it has to compete with large multinational corporations for access to research and development opportunities and access to technologies through intellectual property rights. The cost of innovation and technology development could be a significant barrier to innovation by all but the largest companies. These technologies through patent protection have the potential to create such a significant genetic advantage for the patent holder that its competitors may never be able to catch up. The livestock genetic industry is based on continual improvement and there is no defined end-product so to speak. The goal and thus the end product constantly changes. Thus any significant advantage acquired by one group could essentially put that group at the front and keep it there. Therefore access to all technology is a fundamental principle that the Canadian livestock genetics industry is built on. A lack of access could result in a significant barrier to entry into the industry in addition a competitive disadvantage for current industry players.

Consolidation in the industry is a major concern as a result of intellectual property rights. As has been experienced in the crop industry the vertical integration and resulting consolidation was driven by the need to have a dissemination and marketing infrastructure for the enhanced genetic products being produced. This is a barrier to competition as it limits the means that

other companies have of disseminating their products and limits the choices available to the commercial industry. The biopharmaceutical industry is unique and cannot be directly compared to the livestock genetics industry. The biopharmaceutical industry has a focus on one particular product that is usually controlled by one or a few genes. There is no focus on the improvement of the whole animal because the environment in which the animal is housed will be optimized to enhance the production of the desired pharmaceutical or compound. This non-traditional approach to utilizing livestock results in a totally different set of criteria and industry issues compared to the traditional role of livestock as a food producing resource. Therefore these two industries need to be considered separately when intellectual property rights policies and strategies are being developed.

The government needs to set policy that will position the industry to encourage innovation while not limiting the access to technology, research and development. If this is not achieved then intellectual property rights will result in barriers to entry into the industry and barriers to competition in the industry while placing the Canadian livestock genetics industry at a serious competitive disadvantage. The government should consider joint funding with the industry of genetic evaluation technology centers that would foster innovation, provide services to the industry and act as a technology "hub" creating synergies for the industry. The government needs to develop policy that ensures access to varied breed resources by the Canadian industry as these breeds will always serve as a foundation as well as a resource for the future. Livestock genetics are a major resource for livestock agriculture and biotechnology/molecular genetics coupled with quantitative genetics will be major drivers of innovation in the livestock genetic industry. The key issue is how to get these components together to enhance sustainable development of the Canadian livestock genetic industry.

The following recommendations should be considered in the development of Intellectual Property Rights strategies for higher life forms with respect to the Canadian livestock genetics industries:

1. Develop methods to encourage innovation through strong public and private research sectors.
2. Develop enhanced intellectual property rights policies and strategies that encourage and foster development while not creating barriers to entry, access to technology or significant consolidation in the industry.
3. Develop policies and agreements to ensure that sufficient genetic resources are available both domestically and internationally for use by the Canadian livestock genetic industry.
4. Hold public consultations with the Canadian livestock genetics industry to increase their awareness of the issues of intellectual property rights and gather input for public policy development.

Introduction

Artificial selection and controlled mating of livestock by humans has been practiced for centuries. This form of "engineering" to enhance the desired attributes of the livestock has resulted in many changes in the productivity, performance, size, shape and observed characteristics of livestock. In addition to this artificial selection, there has been natural selection occurring as well. Natural selection relates more to the overall fitness or well-being of the animal and at times could be antagonistic to the efforts of artificial selection. While very effective, artificial selection was practiced on the "whole" animal and changes in frequency of genes were measured indirectly through analysis of animal performance. Until recently these were the only methods available to animal breeders. The advent of biotechnology has allowed the development of techniques that can directly identify specific genes. Not only has this resulted in identification of individual genes that have major effects on certain traits but it has also lead to methods that can quickly change the frequency of a single gene in a population of animals. In addition, techniques are being developed that allow targeted transfer and manipulation of individual genes among different species of livestock. Identified genes and "DNA fragments" known generally as gene markers are intellectual property and as such can be protected through Intellectual Property Rights under the patent laws of Canada. In addition, patenting of individual livestock containing unique gene(s) is possible in some countries. The application of these and related technologies and Intellectual Property Rights could have a significant impact on the Canadian livestock genetics industry.

Nature of Animal Breeding

The current genetic resources for the important livestock species in Canada are quite large. In the dairy cattle, beef cattle and pig industries there are a few dominant breeds as measured by numbers of animals. However there are many minor breeds in each of these species such that the genetic pool, so to speak is large. There have been recent efforts to conserve some of the very rare breeds in Canada and across the world. This effort is likely to continue as effective strategies for preservation are developed.

The dairy cattle industry is dominated by the Holstein breed with more than 85% of the 1.4 million head Canadian dairy herd being Holstein in 1999. There are six other primary dairy cattle breeds: Ayrshire, Jersey, Brown Swiss, Canadienne, Guernsey and Milking Shorthorn (P. Doyle, http://www.agr.ca/cb/factsheets/2dairy_e.html).

In 1999 four major swine breeds (Duroc, Hampshire, Landrace and Yorkshire) accounted for 98.9% of the 65,110 purebred registrations in Canada (Canadian Livestock Records Corporation, http://www.clrc.on.ca/swinereg1999.html). In addition many swine breeding stock in Canada are not registered directly with the Canadian Livestock Records Corporation and are owned by national and multi-national pig breeding companies. There is no accurate record of the number of swine owned by these organizations.

The beef cattle breeding industry is dominated by five major breeds: Angus, Charolais, Hereford, Limousin and Simmental. Combined these five breeds registered 144,727 animals, with Angus registering the most (47,026) followed by Charolais (33,410), Simmental (30,091), Hereford (27,000) and Limousin (7,200). These numbers were collected using association annual reports or via personal communication with the respective association representative. There are several other smaller breeds in Canada but since many of the breed associations register their own animals as opposed to using the Canadian Livestock Records Corporation accurate numbers on all breeds were not available.

The sheep breeding industry in Canada is characterized by many breeds and many small flocks. In 1999 there were 15,161 sheep registered with the Canadian Livestock Records Corporation. Of these, 52% were from the Suffolk, Rideau Arcott or Dorset breeds. The remaining 48% were from 29 other recognized breeds. Clearly the sheep breeding industry is very fragmented with no national genetic improvement program and little leadership in genetic improvement from any particular breed association. A few regional programs organized by small numbers of breeders exist and are very focused in their genetic improvement efforts (eg. Western Suffolk Sire Referencing Scheme, C. Gallivan, pers. comm.).

In general, the genetic diversity available both nationally and internationally is quite acceptable for the dairy, beef, swine and sheep breeding industries. The size is sufficiently large to support the genetic improvement needs of the country and favourable genetic progress could be made in all industries.

Horse Industry

The horse industry represents a unique situation in the Canadian livestock industry. Since the use of horses in Canada is almost exclusively for non-food purposes the factors driving genetic improvement are very different from the other four industries mentioned earlier. High performing race horses are protected from theft, injury and other accidents through commercial insurance policies. In addition, the breeding side of the industry is highly controlled with limited use of artificial insemination and in most cases a requirement for registration of animals. Therefore the industry is quite unique and will not be dealt with in this paper.

Role of Conventional Genetic Improvement

Genetic improvement in livestock is a fundamental driver of change and profitability for the Canadian industries. Genetic potential of individual livestock sets the limit on potential production from that animal. The animal will perform at it's limit assuming it is managed to allow it to express it's genetic potential. All genetic improvement programs focus on traits of economic importance to the profitability of the industry.

Genetic improvement is a structured process that includes the following 5 steps:

1. Set goals and objectives for improvement
2. Create improved genetic material
3. Multiply the improved genetic material
4. Disseminate the improved genetic material
5. Evaluate the change in the target population

Through implementation of structured genetic improvement programs the competitive position of Canada's livestock industries are enhanced. Profitability through efficient production of high quality products for the domestic market is a major focus but exports are also a major focus. Exports of live slaughter animals, carcasses or food products are a major economic contributor to the Canadian agricultural economy. Since 1990, red meat and live animal exports have increased from $1.9 billion to $4.5 billion and from 1994 to 1999 red meat exports increased 84% (Agriculture and Agri-Food Canada, http://www.agr.ca/cb/factsheets/2red_e.html). In addition Canada has a reputation as an exporter of high quality genetics to the rest of the world. In 1999 Canada exported almost $143 million of dairy genetic materials to 47 countries worldwide (Dairy Section, Agriculture and Agri-Food Canada).

All current genetic improvement programs focus on several traits of economic importance. It is this focus on multiple traits through one genetic evaluation program that creates a very powerful tool since profitability is obviously influenced by more than just one trait. Canada has developed very strong livestock genetic improvement programs. The initial programs were funded and delivered by a partnership between the federal and provincial governments. Since approximately 1995, all programs have been turned over to the industry groups to develop program and delivery structures that were most efficient for their respective industries. The dairy, beef and swine industries have kept national genetic evaluation programs in place. In the case of beef cattle the programs are run by the respective national breed organizations while both the dairy and swine industries have one national evaluation centre. The sheep industry has not been very successful in organizing a national genetic improvement program.

The foundation of all genetic improvement programs is the accurate collection of animal based information and pedigree data. The animal based information takes many forms but focuses on the animal traits that affect profitability. The pedigree data is collected by producers and verified by breed associations or their designates as outlined in the Animal Pedigree Act. The pedigree and animal-based data are combined over years and statistically analyzed to produce the best estimate of an animal's true genetic value known as an Estimated Breeding Value. The methodology of computing Estimated Breeding Values has been developed over many years through research and development efforts and continues today. As new genetic evaluation technologies are developed they are implemented and with them comes the ability to evaluate a new trait(s) of economic importance or more accurately evaluate a current trait. Canadian researchers have been world leaders in development of genetic evaluation methods and genetic improvement programs. Estimated Breeding Values for swine genetic improvement programs were pioneered in Canada and incorporated in to

the Canadian national genetic evaluation program in the late 1980's. Since then every major private industry breeding company has implemented that system of genetic evaluation as well as most countries with national swine breeding industries.

Improved genetic material is multiplied by the breeding sector of the industry to ensure sufficient supply for the Canadian commercial industry plus export markets. Dissemination of the improved genetic material is a key component of any genetic improvement system. Artificial insemination is a key technology used to disseminate improved genetics. Other technologies used for this purpose include multiple ovulation and embryo transfer. The final component of any genetic improvement system is to monitor change in the target populations. Excellent cooperation and sharing of performance and other key information from the commercial sector of the livestock industries allows the seedstock industry to evaluate the effect of their genetic decisions and also provides a key feedback system to ensure that needs of the commercial industry are incorporated in to the objectives and goals of the genetic improvement program. This step enables the loop to be closed and ensures that focused genetic improvement programs result for the benefit of the whole industry.

Potential Impacts of Adopting an Intellectual Property Rights System

Currently a system of livestock registration exists that is based on the *Animal Pedigree Act*. The purposes of the *Animal Pedigree Act* are to:

1. promote breed improvement,
2. protect persons who raise and purchase animals by providing for the establishment of animal pedigree associations that are authorized to register and identify animals that, in the opinion of the Minister, have significant value.

Animal pedigree associations (breed associations) under the act have exclusive authority for a breed(s) and represent its membership (breeders) throughout Canada with respect to that breed. Breeds approved under the *Animal Pedigree Act* must be unique and distinguishable. Only one association may be established, in respect of a breed in Canada which confers exclusive authority to set breed standards, define purebred, establish rules of eligibility for registration, maintain a national public registry and issue registration certificates. The act also provides protection for breeders and buyers of purebred animals. Registration of animals combines information on individual animal identification, owner, pedigree or ancestry and other relevant information and registration certificates may only be issued under the authority of one breed association. Breed associations must define the rules of eligibility for registration in the association's bylaws. Any animal sold as purebred, registered or eligible to be registered puts a legal obligation on the seller to provide a duly transferred certificate of registration to the buyer within six months of the sale. Clearly the intention of the act is to provide a means of certifying the genetic purity of an animal and promote breed improvement through the breed association.

This system of livestock registration has been intimately involved in livestock genetic improvement in Canada. The pedigree information required for genetic evaluation is almost

exclusively supplied by the breed association and in most cases the breed association or a group approved by the association also collects and submits the individual animal performance information. Genetic evaluations of individual animals are conducted either directly or by a group approved by the association for its members. This collective system of improvement is based on frequent and open exchange of genetic material among the breeders. In this way more rapid improvement can be made than any individual breeder can obtain working independently. Breed associations, for all practical purposes are simply a group of breeders working collectively to make improvements in their breed. More recently certain groups within some livestock industries, mostly pig breeding companies have moved away from a public system of registration and the use of breed associations for breed improvement purposes. These companies usually have significantly more animals under their control than individual breed association members and can develop and maintain an internal system of pedigree tracking and in most cases an exclusive system of genetic evaluation. These companies in essence have integrated all aspects of genetic improvement into an internal function of the company. These companies almost exclusively control their own improved genetic material and do not share or sell any breeding stock to individual breeders or other companies. However most of these companies still source their foundation genetic resources from individual purebred breeders worldwide. In addition there are several smaller companies and larger breeders or groups of breeders that use combinations of public registration and genetic improvement services and exchange genetics with other breeders or companies on a limited basis.

Access to and Exchange of Genetic Resources

Development of an Intellectual Property Rights (IPR) system would impact the access to and exchange of genetic resources. There already exists protective mechanisms that are used by livestock breeders and breeding companies. These include secrecy, control of genetic material, hybridization, licensing and trademarks (Amanor-Boadu, Freeman and Martin, 1995). These protective mechanisms already limit the access and exchange of genetic resources among individuals. This limit to access and exchange has not had a significant impact on genetic improvement to date because the technology required to make genetic improvement has not been limited. All members of the industry can still access either collectively or individually pedigree and performance data, genetic evaluation methodology and any other genetic improvement technologies. Thus breeders can move the genetic merit of a population of animals using these tools. In addition, individuals can still acquire genetic resources because there are many independent breeders that will sell purebred animals. The difference between success and failure has been the ability to apply the technology, principles and a system of genetic improvement not access to genetic resources. However there are differences between the current situation and system that provides IPR for whole animals. At the heart of this difference is access to the genetic resources. If the effect of the genetics that is patented is so large that others means of achieving that advantage are either too long or too costly to be profitable then the patent holder has a significant advantage that others may never be able to overcome even if access to the genetic material is allowed several years in the future. This would in effect provide a barrier to entry and limit the competitive position of other breeders in the industry. IPR may also restrict exchange of genetic material which will have a direct effect on the size of populations and available

genetic variation in the population. Reduced exchange of genetic material will essentially create many smaller subpopulations within a larger population. If genetic improvement is practiced within the subpopulations the rate of improvement will be reduced because of the decrease in available animals for selection. Without sufficient genetic variation rates of genetic improvement in livestock populations will be greatly reduced because animals will be genetically more uniform which reduces the ability to find outliers in the population.

Genetic Change and Dissemination of Improved Genetics

Genetic change presently occurs at a slow but steady rate. While the gain acquired in any one year may not be large the overall effect of continued genetic improvement is cumulative and thus results in significant change over time. This feature of present genetic improvement systems requires that a disciplined program be initiated and maintained because there are no "quick fixes" so to speak. It also means that competitors in the industry do not normally get a large advantage over others such that competition is not limited. However given recent advances in biotechnology and molecular genetics the possibility of finding and patenting genetic material that could provide a substantial advantage has increased significantly. For instance it would not be surprising to find a gene that would make a change immediately in a population that would take ten or more years of intense selection to achieve under current genetic improvement systems. This would provide a significant competitive advantage for the patent holder. Even if access to the genetic material was provided at some later date the probability is low that a competitor would be able to incorporate the genetic material and then catch-up to the original patent holder. This is due to the fact that the original patent holder would not simply stop making genetic improvement once they had incorporated the improved genetic material but would continue with a genetic improvement program. Given the cumulative nature of genetic change the overall advantage would be significant.

Cost of innovation and technology development is certainly an issue. Individual breeders or groups of breeders generally do not have the resources, either financial or physical to embark on a biotechnology or molecular genetics research and development program or purchase rights to already developed technology. These programs are very expensive and even current government initiatives of matching funding programs are not sufficient to overcome these barriers. In addition there are always intellectual property issues that need to be sorted out among the various partners be they university or government research partners. All of these issues are barriers to individuals or breeding groups competing on an equal basis with large companies, mostly multi-national in origin. This results in a barrier to innovation and entry for these individuals.

Dissemination of improved genetics is another issue. Vertical integration has become an issue in many of the livestock industries. IPR can affect firm entry, make vertical integration in downstream industries more or less necessary and create financial incentives for downstream mergers and acquisitions (Lesser, 1998). This has been the experience of the seed industry. It is not difficult to envision a structure whereby the genetic resources are closely held by a few key players, protected by IPR and then these companies would acquire distribution and marketing infrastructure to ensure complete control of their product. This would result in significant change to the breeding industry. There have already been several

mergers in the cattle artificial insemination industry as the structure of the commercial industry has changed. Further changes, involving integration with key genetic material would be a further competitive barrier to livestock breeders if they could not access efficient and effective means of disseminating their product to a large customer base. This would result in further consolidation in the industry thereby forcing smaller and likely independent breeders out of the business and further limiting choice of the commercial livestock sector with respect to their genetic options.

Biopharmaceutical and Livestock Genetic Improvement Industries – Key differences

There are fundamental difference between the biopharmaceutical industry and the traditional genetic improvement/commercial production industry. That difference is the production of food versus non-food products. The biopharmaceutical industry is focused on using farm animals, mainly livestock to produce a valuable pharmaceutical protein or other valuable chemical compound. This is a focus on a singular trait or genetic material. This requires a small number of animals containing the genetic ability to produce the intended product and in many cases the carrier of the product, mostly milk to date is a byproduct and not available for human consumption. The facilities and access to these specialized livestock are strictly controlled. Development of these specialized livestock usually result from a decision to incorporate one or a very small number of genes into an animal. The systems of incorporation, while relying on breeding so to speak are very different from traditional genetic improvement focused on improving a population of animals. The focus is usually on a very small number of animals, in many cases one, and then using other technologies to replicate the presence of the genetic material in a few more livestock. The total number of animals is usually very small compared to traditional improvement programs that deal with large populations of animals.

Traditional livestock industries focus on food production. This requires a focus on many economically important traits at the same time. Not only must the livestock production be efficient, the food product must be of high quality and the animal, especially the reproducing female must survive for several years in her specific production environment. In addition the breeder is producing livestock genetics for a variety of production environments (eg. Northern Alberta vs Southern Ontario) that may be different from the one in which he is located. All of these factors will affect the profitability of the livestock operation. Therefore the breeder must focus attention on several traits at the same time and cannot be singularly focused on one trait or even gene. This multiple trait approach greatly complicates genetic improvement and reduces the amount of genetic change that can be made in any one trait in favour of overall improvement in several traits. Thus livestock breeders need access to a large population of animals from which to derive and improve the multitude of important traits. Genetic variation is a key driver for genetic improvement and accessing large populations or resource bases is a requirement to secure genetic variation for the many important traits. No one animal contains all the traits in perfect combination and therefore genetic improvement is a system of small incremental changes in a number of traits all focused on an overall goal.

Clearly these two industries are very different and therefore it is not unreasonable to expect that intellectual property rights issues and methods could be quite different. The application of new technologies and specific genes to food production genetics is occurring. Marker assisted selection has been incorporated in dairy cattle and pig breeding programs to increase the rate of genetic improvement. The potential to include a phytase gene in pigs to reduce the environmental impact of pig manure is being developed. The gene causing susceptibility to stress in pigs resulting in reduced meat quality has been eliminated or controlled in modern pig breeding programs. The key though is that these technologies are accessible by livestock breeders and that all of these technologies were applied to increase the rate of genetic improvement, improve production efficiency or product quality while maintaining or enhancing profitability. Therefore one important IPR issue is how does the IPR system ensure wide access to the technology at a reasonable cost.

Implications for Animal Genetic Improvement Research

Clearly genetic research at both the public and private level has moved towards a biotechnology and molecular genetics focus and away from the traditional quantitative genetics area. This coupled with matching funds programs and the opportunity for income stream for researchers and research programs from royalty programs, licenses, etc. has significantly changed the focus of research in the last several years. Canadian producer groups have funded research projects to answer immediate questions and develop immediately required technologies to remain competitive but there has not been a long-term focus to these projects. Canadian breeding companies and individual breeders are at a disadvantage because of their smaller size and the amount of investment required to fund this type of research or acquire the rights to the technologies. An example is the sperm sexing technology being developed by GENSEL Biotechnologies Ltd.. This technology was invented at the University of Guelph and GENSEL was formed to develop the technology and bring it to the marketplace. This technology has huge implications for genetic improvement programs because of the ability to control the sex of the offspring through sperm sorting. GENSEL has three strategic agreements in place that will assist in the development of this technology. The agreements are with Genus PLC, Ridley Inc. and Monsanto Company, all internationally controlled companies. In all cases the agreements provide the partners with a right for an exclusive license to the technology in certain geographic regions of the world (http://www.biotech-info.net/gensel.html). This is just an example of a Canadian invented technology that is being developed with non-Canadian partners and may result in limited access to the technology by Canadian livestock breeders.

Clearly IPR can assist in driving innovation and development but the balance between private sector control of resulting technologies and public sector access must be found. In discussing this issue for the plant industry Lesser (1995) strongly recommended that public breeding research (Plant Breeders Rights issues) be continued as a hedge against domination by the private sector. Strong public research programs in livestock genetics would provide a technology base that was available to the public sector and private companies while playing a key role in innovation for the Canadian livestock genetic industries.

Governments Responses to the Needs of the Animal Genetic Improvement System

The livestock genetic industry in Canada has contributed significantly to the Canadian economy and agricultural economy specifically. The government needs to find ways of positioning this industry such that innovation is encouraged and access to technology and genetic material is not limited. Government should strongly consider jointly funding with industry the development of genetic evaluation technology centres. These centres would focus the resources required to develop and provide genetic evaluation technology services to the livestock industry, focus innovation and technology research and development, and provide the Canadian private sector companies and breed associations with a geographic "hub" at which to locate to enhance synergies. These centres would enhance any Canadian intellectual property strategy because a strong research and development base is a prerequisite for intellectual property development. In addition access to entry into the industry is an issue that needs to be considered. The potentially high cost of acquiring IPR for certain key technologies or accessing the technologies through agreements, licenses, etc. can be prohibitive for smaller companies wishing to enter the livestock genetic industry. Government should focus some attention on ensuring that germplasm is kept pure and available for public access since these distinct genetic packages will always provide a readily available source of foundation germplasm. This effort could be part of an international biodiversity strategy. The *Animal Pedigree Act* may have a role to play in as much as it assists individual livestock breeders with ensuring the purity of breeds. The key will be to balance the needs for innovation with the preservation of genetic resources and an independent Canadian livestock genetic industry.

Conclusions

The Canadian livestock genetic industry has played a crucial role in the development of the livestock industry in Canada. In addition to enhancing the competitiveness of the industry it has also contributed to the profitability of the industry through export of enhanced livestock germplasm and development of innovative technologies for domestic and international use. Fostering further development of the livestock genetic industry during the development and implementation of new technologies brought about by the current and future biotechnology and molecular genetic innovations would be a valuable investment in Canadian agriculture. Innovation is a key to this development but so is access to genetic resources. A strong research and development base is required but this much be matched by innovative intellectual property rights policies and strategies that enhance development but do not favour the large companies over the small independent breeders or small Canadian companies. The *Animal Pedigree Act* may have a role to play in regard to access to genetic resources and ensuring the existence of a Canadian based breeding sector.

The following recommendations should be considered in the development of Intellectual Property Rights strategies for higher life forms with respect to the Canadian livestock genetics industries:

1. Develop methods to encourage innovation through strong public and private research sectors.
2. Develop enhanced intellectual property rights policies and strategies that encourage and foster development while not creating barriers to entry, access to technology or significant consolidation in the industry.
3. Develop policies and agreements to ensure that sufficient genetic resources are available both domestically and internationally for use by the Canadian livestock genetic industry.
4. Hold public consultations with the Canadian livestock genetics industry to increase their awareness of the issues of intellectual property rights and gather input for public policy development.

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