Canadian Farm Animal Genetic Resources Foundation

Development of a plan of action to preserve genetic variability and diversity in Canadian farm animals

Project supported by ACAAF program of AAFC

Objective:

The objective of this project is to inventory science-based approaches and develop an action plan for reducing the speed of the current decrease in the genetic variability of Canadian livestock. The project will address genetic variability in both commercial and non-commercial breeds and the interface between the two. As explained below, intense selection of commercial breeds or lines, and the concurrent disappearance of many breeds not in large commercial use, are leading to a rapid decrease in total genetic variability, the effect of which is only beginning to be felt currently. However, this loss of genetic variability is irreversible, and once a crisis point is reached, it will be impossible to restore the genetic variation that is necessary for the industry to genetically improve its products and adapt to new market or health conditions. Several scientific approaches have been described for addressing this challenge, however they have generally not been reviewed for practical use or incorporated into coherent strategies adapted to the needs of each livestock industry, particularly in the Canadian context. By developing such strategies and acting on them soon enough, the Canadian livestock industry can enhance its future competitive position, and ensure that it will be able to supply Canadian consumers with the quality and diversity of products that they are likely to require.

The project calls for the Foundation, in cooperation with scientists and industry representatives on its Board of Directors, advisors at University of Guelph, scientists from the Centre for Animal Genetic Resources (CAGR) recently created by AAFC, to:

- Inventory scientific methods available to reduce decreases in genetic variability of livestock and poultry populations;
- Investigate their possible application to each livestock sector in the Canadian context;
- Set priorities for action in each sector, taking into account international as well as domestic conservation efforts;

The project will review methods to reduce losses in genetic variability for intensely selected commercial populations, and to preserve genetic variability in small populations. It will also address the use of non-commercial populations to restore variability in commercial populations, with or without the help of molecular genetics and genomics. In addition, it will provide specific recommendations for each livestock sector (including poultry) based on an analysis of the

Canadian context but taking into account international efforts and opportunities, and will prioritize the recommendations for each sector. The resulting recommendations can then be used by Canadian livestock and poultry breeding companies, CAGR, conservation organizations and other stakeholders to reduce losses in the genetic variability of the populations they work with.

The Foundation, because it has excellent representations from the industry, conservation groups and the scientific community, is in an ideal position to lead this project. Benefits will occur to the Canadian livestock industry and to Canadian consumers of livestock products. Livestock production accounts for more than 50% of farm gate income in Canada. For beef and pork, but also in areas such as dairy genetics, the generation of revenue is highly dependent on exports, thereby the need to remain highly competitive. Livestock genetic improvement accounts for between one third and more than one half of all productivity gains, depending on the trait being considered.

Background:

Canadian farmers, indeed farmers worldwide, require the best most productive and adaptive livestock and poultry possible. Being in a highly competitive, dynamic industry, there is constant striving for improved performance including among other factors, greater efficiency of production, higher quality dairy products, meat and eggs and greater resistance to contemporary diseases. Primary breeders, A.I. services and other suppliers of farm animal genetics have responded by adopting very successful breeding programs to bring about rapid and constant improvement. However, this has resulted in considerable uniformity in the genotype of stock used in the major industrial countries. The goals and objectives are similar, and so the breeding stock tends to be similar too, even though it may come from several competing sources.
Following are some examples of genetic concentration:

- Poultry breeders have adopted modern genetic and data processing technologies to achieve the desired progress in commercial traits. These programs are costly, and so a consolidation of companies has occurred. There are now three companies holding the genetics for more than 90% of the market for egg-type breeding stock, worldwide. In meat chickens, two companies control most of the market, and two more are fighting for survival. In turkeys, three companies share a small market, and controls 50% of it.

- 95% of dairy cattle in Canada are from the Holstein breed. Currently, one famous bull, Elevation, appears in the pedigree of 98% of the Holstein recorded cow population. Another bull, Starbuck, appears in the pedigree of 95% of the cows. Because Canadian dairy genetics have been heavily exported throughout the world, and continue to do so, the average genetic relationship between the top Holstein bulls in Canada and the Holstein cow population in most other counties is only slightly below that between the same bulls and the Canadian Holstein cow population. Therefore, the use of Holstein genetics from other countries would not be very effective in countering the decline in genetic variability. This is a worldwide problem. We are not only losing breeds, but also losing genetic diversity within the smaller number of surviving breeds.

- The swine industry faces similar challenges, with the increasing market penetration of a handful of international breeders having almost identical selection goals, working with a limited genetic base.

Hobbyists and farmers seeking niche markets sometimes deliberately use traditional sources of genetic stocks rather than contemporary commercial ones. These stocks represent a source of genetic diversity which could be introduced into commercial stocks from time to time in order to restore genetic variability, or which could be used on their own to produce specialty products with value-added characteristics. However, these stocks only survive as long as the individuals that have them persist in their business. They can disappear if markets change or people retire without successors. In addition, once population size is small, which is generally the case for these traditional breeds, preventing a rapid decline in genetic variability is a challenge. If we are to conserve any or all of these resources for possible use by future generations of farmers, concerted action is necessary**.**

Project Plan

Phase 1: Review of scientific methods for the maintenance and use of genetic variability in livestock
Phase 2: Determine options for the application of these methods in the Canadian context.
Phase 3: Establish priorities and develop an action plan for use by the Canadian livestock industry, CAGR and conservation groups.
Phase 4: Simulation study and thesis preparation.

The project will be managed by the Foundation's Executive Vice-President. Scientific input will be obtained from the scientists on the Foundation's Board of Directors, advisors at University of Guelph and CAGR. Industry input will be obtained primarily from representatives on the Foundation's Board of Directors, but the Foundation may also call on others as required. Input will especially be obtained from international organizations such as the FAO, which is developing a world strategy for the management of farm animal genetic resources and has established an international group from over 100 counties in order to do so. A Masters student will be hired for the project. The student shall have appropriate training in quantitative genetics, and a keen interest in genetic diversity and conservation issues. During the first phase of the project, the student will gather and analyze information as directed by the scientists, and prepare reports to be distributed to all stakeholders. During the second and third phases of the project, he/she will gather input by scientists, industry representatives and conservation groups and, in cooperation with the project manager, prepare a report outlining the action plan for each sector. Continued communications with stakeholders will be maintained through the use of the Foundation's newsletter, fact sheets, electronic access, etc.

1. Phase 1

Conduct a review of scientific methods and approaches for the preservation and utilization of genetic diversity in livestock.

Undertake a study of the scientific literature on methods to preserve genetic variability in commercial breeds or lines (where the issue is generally to balance genetic progress and genetic variability) and in non-commercial breeds (where special breeding schemes are usually required to prevent a rapid rise of inbreeding because of the small size of the population). The study should also address methods to detect variability across populations (genomic tools are now becoming available for this purpose), methods to make informed choices on which breeds to conserve, methods to introgress specific genes from non-commercial to commercial breeds or lines, and methods for using non-commercial breeds as a source of new variability in commercial breeds. There is a wealth of information available on these issues, a lot of it from European countries and at the FAO, which can be used as input for a Canadian strategy. However, obtaining, analyzing and compiling this information in a way which is useful to set priorities is a large and time-consuming task. The above will be accomplished by the scientists on the Foundation's Board of Directors, advisors at University of Guelph and CAGR, and by the graduate student hired for the project. The student will be responsible for compiling the review report under the supervision of the advisors at University of Guelph, the Board and project manager (the Foundation Executive Vice-President), and will assist the later with communication activities.

Sub-activities:
1.1 Start up (first project meeting, hiring of student).
1.2 Conduct of the scientific review (see above).
1.3 Communication activities (through newsletter, fact sheets, Web site and data base, translation).
1.4 Coordination (project management and project meetings).

2 Phase 2

Establish options for the applications of the above methods to the Canadian context.

Determine the key issues for each livestock sector in terms of genetic variability, and the options available for remedial action. Options could include the use of foreign as well as domestic sources of genetic variability, whenever this is possible. Input for this step will be obtained from scientists and industry representatives on the Foundation Board, FAO, Canadian Universities, and CAGR. The graduate student will be responsible for compiling this input under the supervision of the advisors at University of Guelph and the project manager.

Sub-activities:
2.1 Establishing options for application: analysis of the situation in each sector, integration of scientific input and industry input, preparation of report.
2.2 Communication activities.
2.3 Coordination.

3 Phase 3

Establish priorities and develop an action plan for the Canadian livestock industry.

Through discussion with all stakeholders (industry, scientific community, conservancy groups, etc.) work to obtain a consensus in each sector about which specific options should be selected and what order of priority they should receive. Under the supervision of the advisors at University of Guelph and the project manager, the graduate student will prepare an action plan containing specific recommendations for action in each sector.

Sub-activities:
3.1 Establishing priorities and developing action plan
3.2 Communication activities
3.3 Project coordination

4. Phase 4

Conduct a simulation study on 1 or 2 specific scenarios and thesis preparation.