also being carried out at Agriculture Canada's **Animal Research Centre (ARC)** in Ottawa, at the **University of Guelph**, Guelph, Ontario and the **University of Montréal** St. Hyacinthe Veterinary College, **Western College of Veterinary Medicine**, Saskatoon, Saskatchewan and others.

These technological advances have at least two major applications in the field of animal production. One such application is genetic engineering of rumen bacteria, a second is molecular genetics and genetic engineering of livestock.

Bacteria that live in one part of the complex stomach of ruminants (cattle, sheep, etc.) are essential for the digestion and utilization of the fibrous feeds (hay, straw, silage) that ruminants eat. These bacteria are then digested further down the tract, serving as a source of protein to the animal. However, the composition of these bacterial proteins that eventually are digested by the animal is not optimal in terms of the nutritional (amino acid) requirements of the ruminant. In Canada, genetic engineering work on rumen bacteria is now underway and is expected to provide the possibility to ensure adequate supply of necessary amino acids, thus reducing or eliminating the need for costly grain and other protein supplements in ruminant rations.

Genetic manipulation of rumen bacteria to improve their ability to degrade fibrous foodstuffs is also being explored. Research being carried out in this area at Agriculture Canada's **ARC** appears to be the most advanced anywhere in the world and has the potential for industrial application within the next five to ten years. It may, for example, generate a new industry to produce and distribute the engineered bacteria to livestock producers as it is anticipated that the rumen microflora may need to be periodically re-seeded with such micro-organisms. Related work in this area is also underway at the **University of Guelph** in cooperation with the **ARC**.

Canadian Holsteins are recognized throughout the world as being among the most productive and efficient milk-producing breeds.

Another crucial area of technology affecting livestock production is molecular genetics and genetic engineering of livestock species. The utilization of growth hormone in milking cows shows potential to increase milk production significantly. Related research is in progress at the **Lennoxville Research Station** of Agriculture Canada and at several Canadian universities. Development of DNA assays to determine the genotype of cattle for milk proteins is underway at the **ARC** and related work is also being carried out at **McGill University**'s Macdonald College. Because the milk protein genotype influences both milk production and cheese quality, the new assays would allow selection in the desirable direction of both milk yield and quality. Identification of other genes directly related to important production parameters is also being investigated currently.

Successful gene transfers in livestock have been carried out at the **University of Calgary** and research on the utilization of transgenic animals in livestock improvement is in progress at the **ARC**.

Studies of the molecular and cellular genetics of chickens, aimed at improvement of genetic resistance to disease, are well advanced at the **ARC**, in close cooperation with Agriculture Canada's **Animal Diseases Research Institute**, located in Ottawa, and **McGill University**'s Macdonald College. For example, these studies deal with genes that are a permanent component of the animal's genetic make-up and whose function is to produce "endogenous" viruses. Reduction or elimination of such genes may improve productivity and health of poultry and livestock species.

Overall, in Canada application of new technologies to livestock production has had a remarkably successful start and, in the case of embryo manipulation, has already produced a significant industry impact. Other areas are approaching points of relatively widespread industrial application and provide extraordinary potential.

A long-established mainstay of the world's livestock industry, Canada is moving confidently into the future. ■