Collection and Application of Genetic Information from a Canadian Perspective

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Introduction

The fundamentals of genetic improvement are accurate pedigree information and performance measures. A cornerstone of BIF is that objective measurement of traits tied to accurate pedigree information allows for effective and directed genetic change.

Historically Canada has been a nation of small independent farmers and ranchers. The vast majority of Canadian beef production by primary producers has left the farm gate at, or soon after, weaning and has been marketed through traditional channels such as auction markets. Genetic improvement has always been the realm of the purebred breeder in Canada, with legal protection under the federal "Animal Pedigree Act" for "purebred" livestock. Often for commercial producers the cost and labour effort required to accurately track pedigree was not offset by a corresponding price premium. A good example of this would be the practice of using multi-sire pastures in commercial production. The Canadian purebred breeder has expected to obtain a premium for animals of known pedigree. Historically there has been an easily recognizable separation between the purebred producer (traditional seedstock producer) and the commercial client. The use of Expected Progeny Differences (EPD) by the purebred breeders has been a mixed bag; some individuals use them for sales and marketing and others for genetic improvement. In most cases phenotypic criteria and reputation of the purebred breeder are still the major drivers in purchase of young purebred bulls by the commercial producers.

Canada is Undergoing Fundamental Structural Changes in Beef Production

Over the past several years Canadian beef producers have faced significant challenges. This includes the obvious ones of BSE and loss of export markets, but also the added cost of SRM removal and disposal, feed ban regulatory costs and the dramatic increase in feed costs faced worldwide. Perhaps the largest challenge has been the relative change in the value of the Canadian and US dollars. The decline of the US Dollar (our largest trading partner) has resulted in the Canadian dollar increasing in value from $0.65 US to even par in the span of 5 years. This has had the dramatic effect of lowering relative feeder cattle prices by 35%.

Canada has approximately 5 million beef cows. As shown in Figure 1, 70% of the beef cows are concentrated in the Alberta and Saskatchewan with a further 17% in Manitoba and British Columbia. These four western provinces completely dominate beef cow numbers in Canada. (Fast Facts, 2007).

The beef cow inventory grew relatively rapidly following 2003, when BSE resulted in closed markets for OTM (Over Thirty Month) beef (Figure 2). As processing capacity has come available for cow slaughter, the inventory numbers have declined somewhat. Canada hit a peak beef cow inventory of just under 5.5 million head in 2005. Currently we are reporting just under 5 million beef cows with a projected further decline into January 2009 inventory reporting (Canfax, 2008).

According to the 2006 Census of Agriculture, there

were 83,000 farms and ranches in Canada reporting beef cows. The average age of producers was 52 (up from 49 in 2001) and the average herd size was 61 (up from 53 in 2001). The number of beef farms has decreased by 8% from the 2001 census, exceeding the rate of general farm attrition by 1%.

These census numbers and the beef cow inventory numbers indicate a relatively rapid consolidation of the Canadian beef industry. While we are a nation of small producers with over 60% of producers having fewer than 47 cows, 13% of producers have in excess of 122 cows and control nearly half of the beef cows (Census of Agriculture 2006a) (Figure 3). Herds in excess of 273 head grew from 8.8% of farms to 11.2% between 2001 and 2006. In 2006, 1,043 or 0.9% of the farms controlled almost 20% of the beef cows in Canada (G. Winslow, Cattlemen Magazine, October 2007).

Canada's feedlot industry is also undergoing structural change. Canada fed approximately 3.6 million head of beef cattle in 2006 (Fast Facts, 2007) with the remainder of the feeder cattle for the most part exported to US feedlots. The Canadian feeding industry is centred n Alberta. Over 67% of fed cattle production was in Alberta with another 10% in the remaining three western provinces. Ontario has approximately 20% of fed cattle production. Feedlot bunk capacity is also consolidating. In Alberta, 20 feedlots control 46% of the bunk space and nine feedlots control 59% of the bunk space in Saskatchewan (G. Winslow, Cattlemen Magazine, October 2007). The story is much the same in the packing industry. Two plants (Cargill and Tyson) represent the vast majority of Canadian slaughter capacity (90%) are also located in Alberta as is the third largest federally inspected plant.

The 2006 Census of Agriculture also indicates a rapid growth in the number of corporate farms (family corporations) (Table 1) and the number of farms with gross revenues exceeding $250,000.

Further analysis shows that the education level of producers is increasing and that the adoption of computer technology for management is on a rapid incline (Figure 4). It is important to note that although computer use permeates slightly less than 50% of farms, that these farms represent well in excess of 50% of Canadian agricultural capacity.

The Canadian beef industry is extremely export dependent. This is part of the reason that Canada implemented mandatory national identification in January of 2001 (CCIA, 2008). No animal is permitted to leave its' herd of origin without an approved RFID tag. We have just less than 1.5% of the cattle in the world; however we are one of the top 5 exporters. Canada exports in excess of 50% of its production, and 35% of net production (exports – imports). The majority (81%) of exports are to the US (Fast Facts, 2007). Beef export highs were set in 2002 (469,490 MT), and 2007 export levels were still 30% below that level at 326,723 MT (Canfax, June 13 2008).

We also send a large number of feeder cattle to US finishing lots. Current year to date numbers (Canfax, June 13 2008) are just under 327,000 head. This is largely driven by the cost of feeding cattle, primarily feed cost.

Canada has also seen the development of some value chain/branded program structures across the country with varying protocols, including organic, natural, EU certified and breed/breeder specific examples. While small in number the popularity of these kinds of structures appears to be growing and experience has been gained as various arrangements have been tried.

As stated earlier, Canada still has a large number

of small herds however over the last several years traditional paradigms have been changing in Canada as the beef industry consolidates resulting in fundamental changes in the control of the commercial cow herd and feedlots. In addition larger commercial herds and feedlots generally allow for greater technology adoption. These structural changes will have implications for the collection and application of genetic information at both the commercial and purebred levels.

Implications for Genetic Improvement

The movement to larger commercial cow herds or control of more commercial cows into fewer hands, with reduced labour per cow available is having a profound effect on the genetic needs of these herds and consequently the market for purebred breeders. Most of the commercial herds are composed of crossbred cows and many use a terminal sire approach to produce the majority of their market cattle. This management practice usually results in two different types of breeding bulls and most breeding pastures are large with multiple sires per pasture. The development of reliable estrus synchronisation programs has rapidly moved many of the larger commercial herds to use high accuracy sires through AI to produce predictable packages of calves. Commercial herd AI use has grown rapidly and now represents over 50% of total beef semen sales with many herds using several hundred units of one or two bulls (R. Carlson, personal communication). Many of these herds also have a relationship with one or a few feedlots or retain ownership, at least partially through to harvest. Finally all calves are being individually identified on-farm which supports the efforts of cow herd owners to follow their cattle through the system.

The question that needs to be asked is quite simple: How have purebred breeders responded to these fundamental changes? One way to look at this question is from traditional breed association statistics. Figures 5, 6 and 7 show the trend in registrations, transfers and cows enrolled on inventory-based performance programs. Clearly in all cases the trends are not one of increased activity. The issue of registrations and transfer are probably being driven by perceived value by customers in a registration paper. Anecdotal evidence would suggest that when given a choice, even without a cost customers purchasing yearling bulls do not ask for a transfer of registration. This decision seems to be regardless of purebred herd size.

Interestingly though, perception among several of the breed associations is that even though total cow enrolment is declining there is a clear separation in the membership on this issue. It seems that complete herds are opting out of enrolment not necessarily fewer cows within a herd. Many of the larger herds appear to be maintaining cow herd enrolment while some smaller herds are not enrolling at all, even in cases where enrolment is mandatory for participation in the performance and genetic evaluation programs.

Many of the purebred breeders have increased herd size and moved their focus to capture commercial herd business on both an increased scale and number of breeds they offer. This movement is driven by the desire of larger commercial customers to purchase all of their replacement bulls from one seedstock supplier. This requires not only a larger number of bulls within any given breed but also bulls of different breeds and hybrid bulls designed to meet commercial customer needs. Clearly this has resulted in a move from a traditional purebred breeder concept of offering one breed of cattle to a seedstock supplier concept offering choices among breeds and hybrids and in many cases even distinctions (colour based) within a breed.

Adoption of technology by purebred breeders has

been limited in Canada. An excellent example is that of collection and use of ultrasound and carcass data. Based on numbers available on breed association web sites, ultrasound data has been collected on a small percentage of animals (4 to 14% of registered animals). Actual carcass data used for genetic evaluation purposes has been estimated to be less than 12,000 records from purebred cattle and organised progeny test programs. Clearly, there has been limited focus on ultrasound and carcass trait data collection programs by breeders even though the use of packer grids has significantly increased.

However things are not as negative as they seem. The number of seedstock suppliers is growing and the demand from commercial producers, especially the larger commercial producers is driving this demand. The integration of commercial producers into cooperative marketing, retained ownership and value-based/grid systems is focusing a renewed interest in genetic potential of their cattle. The ability for commercial producers to get meaningful feedback on their cattle is creating this "demand pull" for genetics as opposed to the "technology push" that has existed in the past. Some seedstock suppliers are developing programs to not only test their own genetics for new traits (e.g. carcass and meat quality) but are forging alliances with commercial producers using their genetics. Most of these relationships are using some form of technology to enhance the relationship. Increasing use of technology will be a cornerstone of these relationships.

An especially important technology adoption will be DNA-based tools at the commercial and seedstock levels. Breed associations have used technology-based parentage verification for many years as a routine monitor of pedigree quality. The move from blood group analysis to microsatellite markers was a technology step that very much improved the ability of the technology to support the needs of breed associations. Now a new level of DNA-based testing, Single Nucleotide Polymorphisms (SNP) is available that is reducing cost for large scale paternity identification and other DNA-based testing. This technology has the potential to move paternity testing into the commercial industry at the level of complete calf crops. At that level of incorporation a commercial herd can have unique identification on every calf in the herd and if continued could have a complete cow herd with known parentage and DNA stored within 6 years given current industry female replacement rates. Some breed associations have recognised the potential impact of this technology and are taking a proactive approach. The Canadian Simmental Association has recently announced a program to collect a tissue/hair sample from all cows in the breed for DNA extraction and storage. Within the commercial herd there is a wealth of management and performance information that this technology could assist in providing to managers of such herds. For example simply knowing how many bulls are producing progeny and how many progeny they produce provides excellent information for bull culling decisions in multiple sire breeding situations. Van Eenennaam et al. 2007 reported tremendous differences among sire progeny output in a group of 27 sires in a commercial ranch setting. In addition, matching a pedigree to an individual RFID identification allows for tracing of performance past the farm gate, especially in retained ownership and value-based programs. Speculation is that feedlots will further increase the use DNA-based tests for marker-assisted management of cattle to ensure sorting into outcome groups to optimize feedlot production and enhance profitability. It is certainly possible that SNP panels for marker-assisted management could be run at the same time that a paternity test is being run to enhance the information and value of weaned calves. The opportunity to carry this

genetic information further to meet packer need is easily accomplished assuming a defined SNP panel focusing on packer-based grids or incentive programs can be identified. This technology creates several opportunities to enhance value and optimise production thereby improving profitability of the commercial cow herds. Finally DNA-based traceability to the packer or retail meat case could be enhanced by a DNA sample on every calf.

However what about the genetic potential of the commercial cow herd itself? Paternity testing of a complete calf crop in a commercial customers herd creates tremendous potential for the seedstock producer. Assuming that all bulls sold to that commercial producer are parentage verified then the coupling of bull parentage identification with the calf paternity identification provides a direct link of commercial data to the seedstock pedigree and performance databases. Enhancement of genetic evaluation through use of commercial herd data could be a reality in the very near future. In fact some of the larger commercial herds could conduct within-herd genetic evaluations based on pedigree data established solely on SNP-based paternity testing. However in our opinion the advantages to both the seedstock and commercial producer by combining data are very synergistic. Integration of pedigree and performance data across breed associations and genetically–linked commercial herds would create a formidable genetic evaluation that would assist commercial herds in selecting male and female replacements and also benefit seedstock suppliers by incorporating commercial data on large herds and potentially feedlot and carcass data. Genomic information from SNP-based tests has recently been incorporated into genetic evaluations by the USDA on behalf of the US dairy industry (http://aipl.arsusda.gov/reference/changes/eval0804.html). This has also been done for a few years now in both the pork and chicken industries. Including genomic information enhances accuracy of genetic evaluations and allows for collection on information on traits that are very difficult to do on a routine basis (e.g. meat quality or health traits).

Linking pedigree and performance at both the level of seedstock and commercial industries along with genomic information all combined into one genetic evaluation tool would provide a tremendous opportunity to move genetic improvement to a new level. The spin-off information on the management side of the equation only adds to the benefits. One need that has been clearly identified is the need to convert information into knowledge that can be used for decision-making. Commercial and seedstock producers alike are rapidly becoming overwhelmed by information. Opportunities exist for those willing to assist in transforming information into knowledge. If the costs of providing genomic technologies continue to decrease as some suggest then application of these technologies in the Canadian beef industry becomes a much more tenable proposition. It requires a level of cooperation and dedication that has rarely been experienced between individuals in different sectors of the Canadian beef industry but survival and competing for new markets will be a great impetus to achieve that goal.

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Figure 1. Beef Cow Distribution in Canada

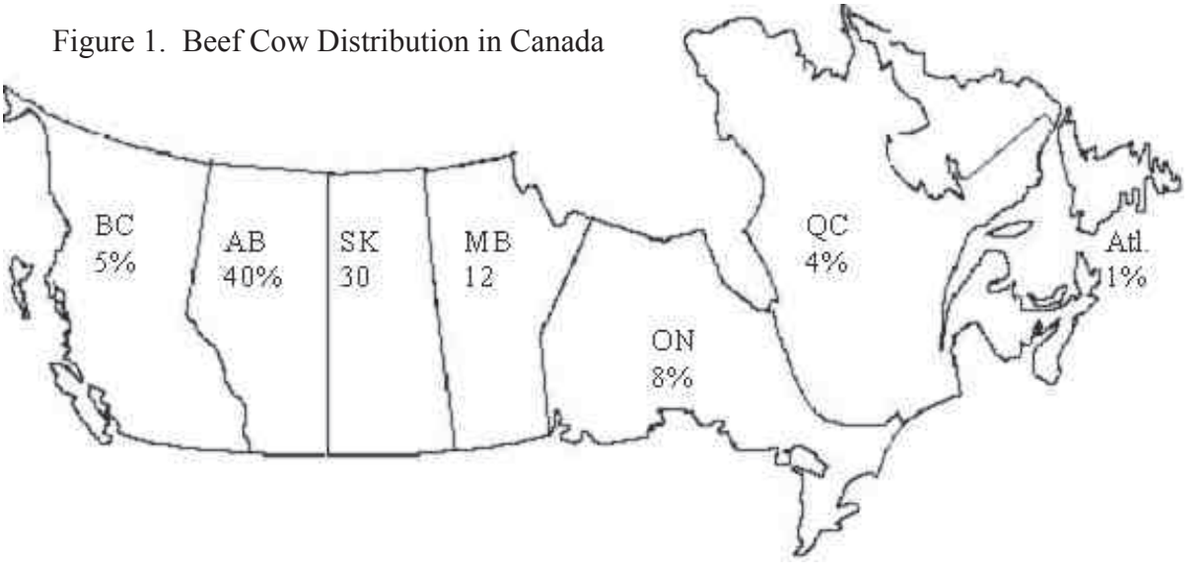

Figure 2. Canadian Beef Cow Inventory Numbers (Jan 1)—Canfax

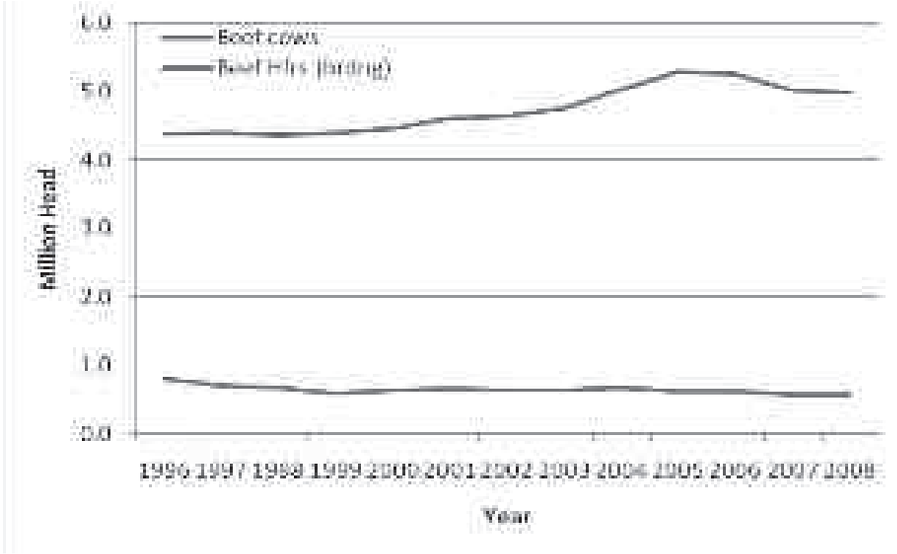

Figure 3. Distribution of Farms and Ranches Relative to Herd Size—Census of Agriculture 2006a

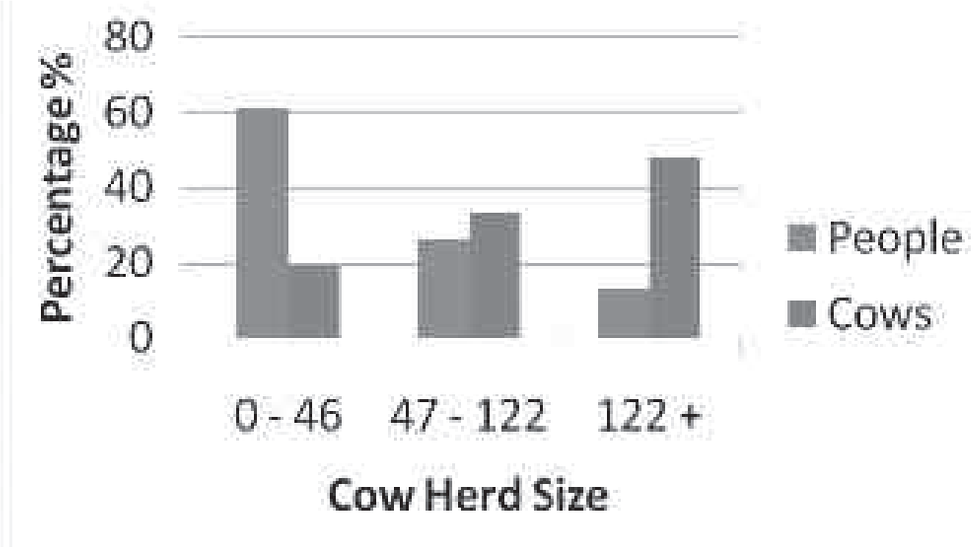

Table 1. Distribution of Farm Structural Types from 1991 to 2006—Census of Agriculture 2006b

Farm Structure	1996	2001	2006
Individual or Family Farm	60.8	57.9	57.1
Partnership with a written agreement	7	6.5	5.6
Partnership with no written agreement	20	21.9	21.1
Family corporation	9.8	11.7	14.1
Non-family corporation	2	1.7	1.9
Other types	0.3	0.3	0.3
Total	100	100	100

Figure 4. Percentage of Farms Reporting Computer Use in Business Management—Census of Agriculture 2006c

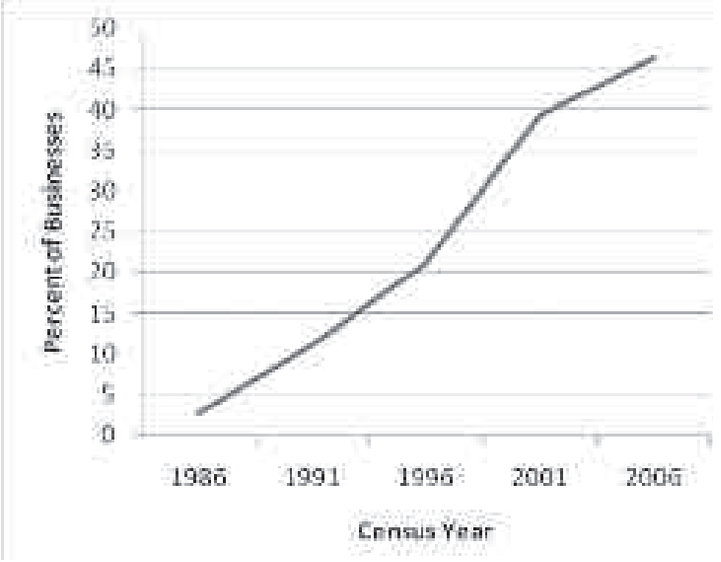

Figure 5. Purebred registration trends in three major Canadian beef breed associations.

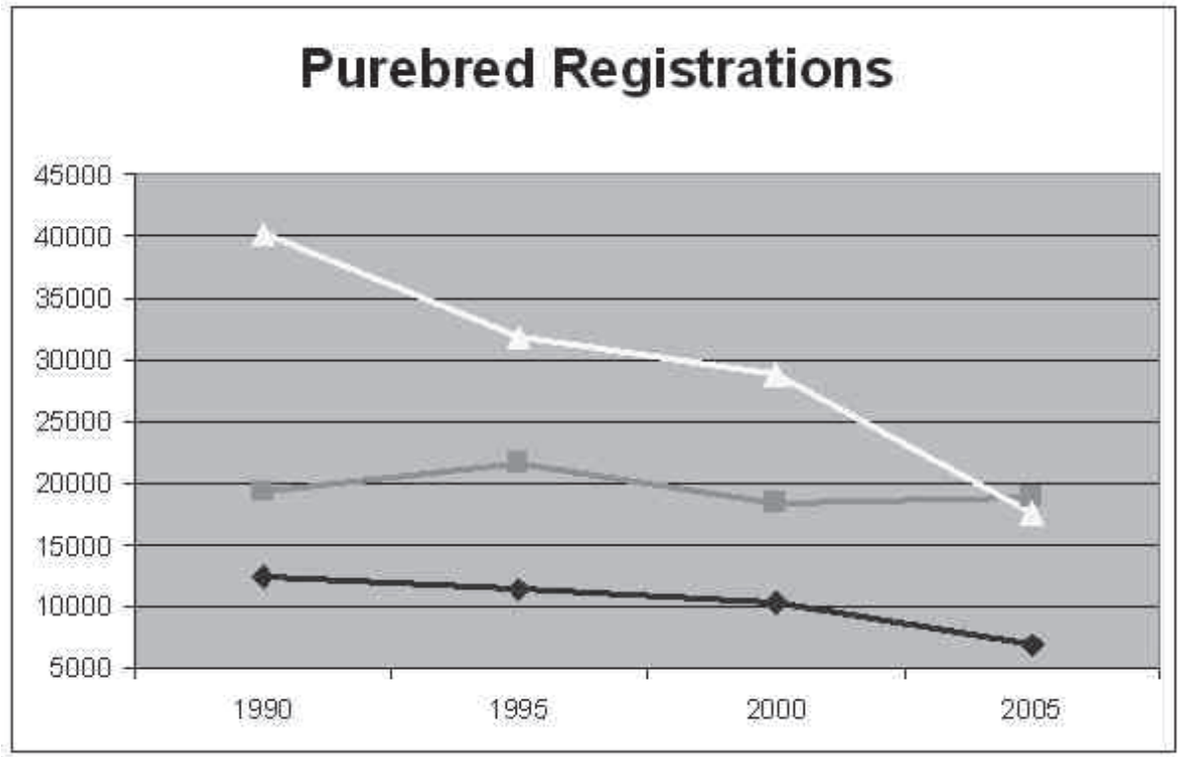

Figure 6. Purebred transfer trends in three major Canadian beef breed associations.

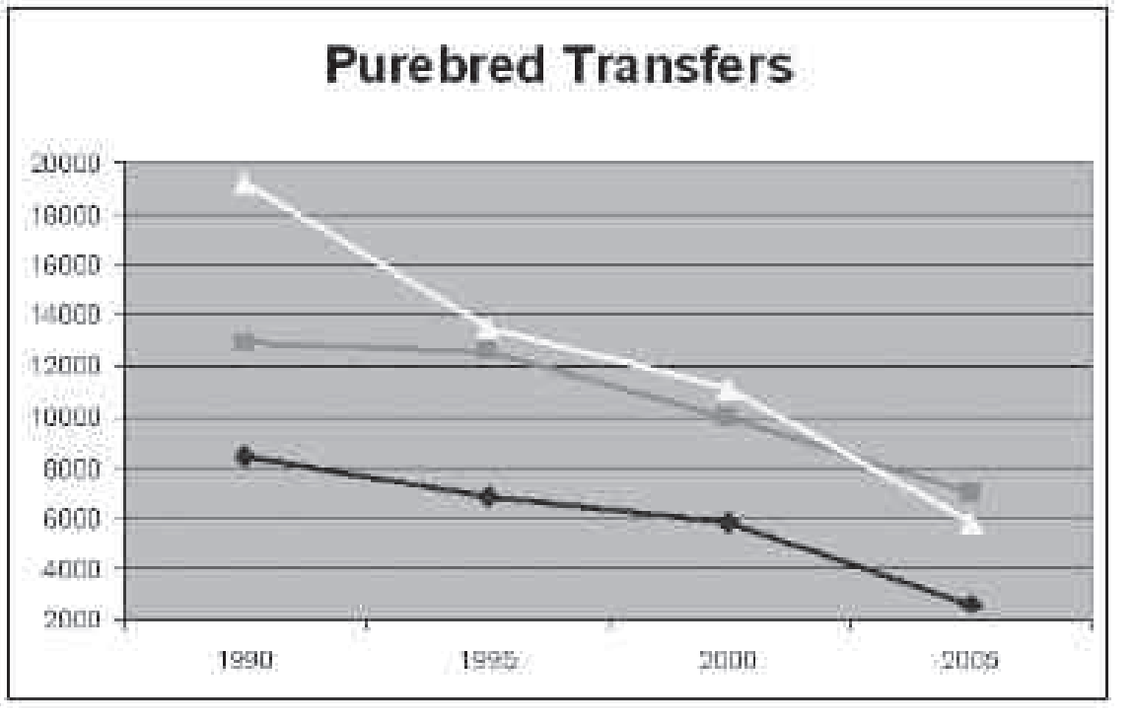

Figure 7. Cow enrolment trends in three major Canadian beef breed associations.