GENETIC IMPROVEMENT PROGRAMS IN CANADA AND ELSEWHERE - SHARED CHALLENGES

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INTRODUCTION

The goal of every individual who breeds livestock should be to plan matings to ensure that offspring are an improvement on their parents. To that end, man has attempted to define and measure "quality" for a variety of species. In addition, scientists have worked to differentiate those aspects of quality which are inherited, and that may be passed on to future generations, from those aspects which are reflections of forces external to the animal.

In the last 50 years, the programs and information used to select beef cattle have changed more than the animals we aim to improve. Parallel changes and ongoing challenges face North American and European countries, and Australia and New Zealand.

VISUAL APPRAISAL

Initially, visual appraisal was our only selection tool. Objective definitions of "quality" have never been obtained where conformation is concerned. Beauty, as the saying goes, is in the eye of the beholder. In addition, beauty in cattle bears little or no relation to production efficiency or meat quality.

Nonetheless, some visually-assessed traits are highly heritable. Witness the dramatic reductions in height achieved by Hereford breeders before the dwarf gene surfaced and turned them from their path of self-destruction. Evidence of the uncertain conformation goals pursued by breeders was the subsequent passion for taller and taller cattle, which halted only when calving difficulties had become rampant.

The drawbacks to visual appraisal have not changed. Luckily, breeders in many countries have changed their approach, and are focusing more on performance than on beauty.

PERFORMANCE RECORDING

As performance recording became popular, many countries and breeders fell into the trap of emphasizing traits which were easy to measure, rather than those which were important economically. This legacy haunts us still. Performance programs around the world measure height, weight, average daily gain, scrotal circumference and other traits related to body size and shape. Only slowly are we discovering the link between these traits and the goals of improved production efficiency and product quality.

Many countries are striving to develop objective, cost-effective means of measuring traits which relate more directly to production efficiency and product quality. The use of ultrasound in the measurement of backfat, rib eye area and marbling on live animals is an example. Ongoing global research will perfect such measures and help us to interpret and use them.

PERFORMANCE RECORDING PROGRAMS

Performance recording programs were developed in parallel in North America and in Europe. Guided by technical experts, all incorporated similar procedures.

Some countries began with organized progeny test programs, run by universities or AI centres. Randomized matings were used to produce many calves per sire, evenly distributed in cooperating herds. The weaning and yearling information collected on their progeny allowed sires to be compared. However, these costly programs assessed only a limited number of sires.

The first exposure most breeders received to performance recording came with the advent of accessible herd test programs. The principles of herd recording are the same world-wide. Calving ease, birth weight, weaning weight and yearling weight have been emphasized. In North American programs, 200 (or 210) day and 365 day weights are the focus. French programs record 120 day weight, believed to be a better indicator of the dam's maternal ability. All herd programs have traditionally allowed only within-herd comparisons.

Early attempts at across-herd comparisons centred on bull test stations. At stations, bulls from different herds are collected to undergo testing in a standardized environment. While many countries developed test station programs, the approaches differed.

In some Scandinavian countries, bull calves destined for stations are weaned very young (one month of age) and sent to the central location. In this way, herd management effects are minimized. In Canada, bulls enter stations shortly after weaning. After a 28 day adjustment period during which feeding level is gradually increased, bulls are fed ad libitum concentrate rations for a test period of 140 days. In France, bulls also enter the stations after weaning. However, they undergo an 8 week adjustment period, followed by a shorter period of ad libitum feeding. This intense feeding is to enable bulls to express compensatory gain resulting from different herd environments. The 14 week test period, on controlled feeding, then begins. Bull testing in Australia and New Zealand has involved prolonged pasture feeding.

Concerns regarding the effectiveness of test stations exist. Selection bias, herd management carry-over effects, compensatory gain and non-linear gain do affect comparisons made within stations. Where the age of bulls at entry and the length of adjustment and test periods are poorly controlled, stations can become more of a marketing venue than a genetic testing ground.

NATIONAL PERFORMANCE RECORDING SYSTEMS

Many countries use the same types of programs in different ways. In Canada, herd testing is the backbone of our system. About 200,000 births are recorded annually, representing almost 20% of registered cows, and 3% of commercial cows. Several herd test programs exist, operated by breed associations and governments. All follow defined national standards and contribute to a national database.

About 85 recognized test stations operate in Canada, following national standards. About 8,000 bulls are tested annually. While many stations are independently run, most operate under provincial government programs. Producers determine which bulls, if any, they will test. Little formal progeny testing occurs.

In the USA, herd performance programs are run by breed associations. Little commercial recording is undertaken. No national database exists. While no national standards exist, the Beef Improvement Federation publishes Guidelines for Uniform Beef Improvement.

Station testing is popular in the USA. Stations are independently run, or run in conjunction with state Beef Improvement Associations. In general, bulls are older than in Canada when they enter the stations, and adjustment and testing periods are shorter. Organized progeny testing is rare.

In France, about 8% of beef calvings are recorded through a national performance program which captures breeding and birth information and weights. From amongst the recorded calves, bulls are selected to enter test stations. The best tested bulls are entered in formal progeny test schemes to obtain maternal and carcass information. A limited number are then approved for AI use.

GENETIC INFORMATION

With the coming of the performance era, many breeders received their first exposure to the concept of "genetic" comparisons. Certain aspects of performance are not genetically controlled, and thus cannot be passed on to the next generation. Such "environmental" factors should not be allowed to influence animal comparison and selection.

Undertaking comparisons within contemporary groups not only provides a frame of reference for comparison, it removes many of the environmental influences. Following adjustment for age, sex and other "non-environmental" factors which complicate comparisons, differences between group-mates raised in the same environment are largely genetic.

The index, also known as a performance ratio, has been widely used for decades in many countries. The index expresses adjusted performance relative to the contemporary group average. Most countries have used 100 as the group average. Calves indexing above 100 are better than average, while those below 100 are poorer than average.

Neither adjusted values nor indexes can be used to compare individuals from different groups or herds. These limitations posed serious problems to breed advancement and marketing. Even the test station did not resolve the dilemma. While the bulls in a test station might come from several herds, bulls in different stations could no more be compared using indexes than could calves in different herds.

THE BLUP AGE

With the development of Best Linear Unbiassed Prediction (BLUP), across-herd comparisons became a reality. Initially, lack of computer power limited the use of BLUP. Later, improved methods and computers allowed widespread release of Estimated Breeding Values (EBVs) and Expected Progeny Differences (EPDs).

BLUP has been applied to dairy cattle evaluation for over a decade. Increased rates of genetic improvement coincided with the introduction of BLUP, since genetic comparisons across the whole population became possible for the first time.

BLUP technology has also been incorporated into beef programs in North America and in Europe. However its incorporation has not been easy, and the effect has not been as great as anticipated. Why? Because BLUP has changed the rules.

Until the introduction of BLUP, each record on an animal was associated with an adjusted value and an index. No weaning weight, no index. Simple.

BLUP however, can combine performance information on related traits (eg. birth, weaning and yearling weight) and on related individuals (sire, dam, siblings, progeny) to produce a genetic value. No weaning weight, no problem! A weaning weight EPD for an animal can be obtained using its yearling weight or its dam's weaning weight or its progeny's birth weight.

The accuracy of the evaluation is obviously affected by the amount and "quality" of information used. "Quality" in this instance refers to how close the relationships are between the animal/trait recorded and the animal/trait being evaluated.

Unlike the indexes or adjusted values, an EPD is not static. Each time new information on a related animal/trait becomes available, the EPD can change.

Yes, BLUP has changed the rules. No longer is there a one-to-one relationship between a piece of performance data and a piece of genetic information. An animal need not even be conceived before its first EPD is calculated. Is it any wonder that breeders become confused?

Unfortunately, beef breeders are particularly subject to this confusion. They have less experience with recording and performance selection than have their dairy counterparts. In addition, the number of important traits is greater in beef cattle breeding, and the relationship of these traits to quality and to profit is more tenuous.

ACCESS TO BLUP

Due to the time, complexities and cost associated with running BLUP evaluations on large national databases, evaluations are generally infrequent and performed by a central agency.

In Canada, a BLUP Individual Animal Model (IAM) combining 7 traits in a simultaneous evaluation is run for 16 breeds on a semi-annual basis by the federal government. In the USA, three universities semi-annually run various different BLUP models under contract to breed associations. Most have yet to move to IAM, multiple trait technology. Some are considering a move to quarterly evaluations. In France, single trait BLUP was recently introduced for bulls undergoing formal progeny testing. BLUP evaluation will soon be introduced for station tested bulls, and then for cows and bulls based on field data. Evaluations are run by the national research institute (INRA).

To the breeder, "central" evaluations are of limited use. While they are helpful in sire selection, culling decisions on cows and calves must often be made shortly after data collection. When no EPD is available, breeders revert to the use of indexes, adjusted performance, or other criterion.

In Canada, micro-computer EPD modules, using BLUP technology in a multiple trait IAM, have been installed in regional and breed offices across the country. These modules, which are linked to the national

evaluations through parent EPDs, produce updated EPDs for bulls, cows and calves. Often, less than two weeks elapse between weigh-day and the return of EPDs to the producer.

American breed associations combine parent EPDs with calf performance (group deviations) to produce timely "pedigree EPDs". No BLUP technology operates outside the universities. France has not decentralized EPD production, but may do so in future.

DUPLICATE EVALUATIONS

The new technology poses serious challenges to those who deliver performance recording programs. With the advent of EPDs, an animal can receive a set of EPDs based on its weaning weight collected on-farm, or its yearling weight collected in a test station. Preferably, these pieces of information will be used together to obtain a better genetic assessment. To do so, the groups running the two programs must cooperate to pool their data, and one BLUP evaluation must be run.

With the proliferation of "interim" EPDs to fill the gap between semi-annual "central" evaluations, an animal's EPD may be reissued three or four times a year.

In France, where expensive progeny test programs are in place, BLUP poses other challenges. How does the breeder differentiate between milk EPDs for two sites, one based on field data collected through a herd program and the other based on expensive, controlled progeny testing in station? Is one set of data "better" than the other?

With the international trade in semen, bulls often sire calves in several countries. Using BLUP techniques, each country can produce a set of EPDs for the bull, based on calves borne within that country. These EPDs will be different, even if all evaluation procedures are identical. Is one "better" than the other?

THE DILEMMA

Our performance recording systems, and the way in which they present information to breeders, were not designed with BLUP in mind.

To use BLUP effectively, data from all types of programs must be integrated. In that way, the most accurate evaluations are produced with the least duplication and confusion. Program rationalization must occur on a domestic level. Several countries, including Canada, are currently in the midst of this process.

In integrating existing types of programs, we must review the purpose of each. For example, station testing is under review in Canada. Testing began to allow across-herd comparisons. Today, BLUP does the job. In fact, central testing now impedes national comparisons. Data collected through herd station programs is handled and stored differently, and uniting the two sets is not an easy task. Specialized BLUP models are required, since contemporary group structures are broken and reformed when bulls enter stations. While stations will have a continuing role, it is a changing one, with the emphasis on specialized trait recording.

THE INTERNATIONAL CHALLENGE

The improvement and marketing of genetic material are global activities. While the international marketplace wants harmonized genetic information, there are many technical and practical impediments.

On a technical level, lack of genetic connections and genetic-environment interactions are two serious restrictions to international genetic evaluations. Minor problems such as trait differences across countries pale next to the challenge of building and analysing a global database. Choosing the location where an international evaluation would be undertaken, and ensuring the credibility of the evaluation team, are major political hurdles.

However, the inherent conflict between individual advantage and collective benefit is perhaps the greatest hurdle of all. Why do breeders compete amongst themselves? Why do breeds and countries and economic communities compete ? As long as nations (as individuals) perceive an advantage in maintaining control over their genetic information, international evaluations will not occur.

The domestic benefits which accrue from genetic improvement, manifest as gains in production efficiency and market competitiveness, far exceed profits from genetic exports. Exports are, in essence, a side-effect of aggressive domestic improvement. Improvement must be tackled within national borders. National production and market environments differ sufficiently. Breeds and breeding systems, production systems, climate, consumer preferences, trade balance, economic alliances : these and many other factors contribute to make domestic control of breeding programs and genetic information essential.

Nonetheless, steps can be taken to simplify international marketing. International conversion formulas for EBVs have been used by the dairy industry for some time. Research into the calculation of such factors is under way in Canada and the USA.

SELECTION

Together with concerns regarding how genetic information is produced and released, there are concerns regarding its use. It is logical to use such information not only for livestock improvement, but to demonstrate the worth of livestock to potential customers. Unfortunately the former activity is often neglected in favour of the latter.

Entrepreneurial breeders in North America have capitalized on station test results as a sales tool. A bull is more desirable if he is a test station graduate. Since the existence of even dismal performance data makes a bull more saleable, few station graduates face culling.

Two philosophies are evident in national approaches taken to selection. France typifies the philosophy of "national selection" for "national benefit". Breeds have nationally approved selection schemes. Often both "balanced" and "terminal" objectives are pursued, supported by sequential herd, station and progeny testing, with strict state-controlled culling. "Balanced" sires are used to perpetuate the breed, while "terminal" sires are used in crossbreeding, mostly within the dairy herd.

Canada, by contrast, displays "free enterprise" selection. Breeders are provided with state-of-the-art genetic information, and advice from researchers and government. Armed with these tools, the breeders make the decisions.

Since breeders are a variable lot, so are their selection objectives. Some don't have any. Some have a different one for each calf crop. Some breed for beauty. Others breed for ribbons. Still others breed for performance. Some breeder categories pose an obvious challenge to advocates of breed improvement through performance. Surprisingly, even those breeders who do select for performance often pose a challenge.

Many producers believe that their breed can be all things to all people. Using genetic information, they attempt to produce "lines" within the breed which typify the ideal slaughter animal, the ideal maternal cow, the ideal terminal sire, etc. Advocates of many different breeds pursue these same ideals. While genetic change is achieved, one must ask: Are we making any progress? Is it beneficial to destroy the genetic variability which can be used to satisfy today's beef market and to respond to the changes tomorrow may bring?

CONCLUSION

The challenges discussed above are broad ones: to obtain objective measures of important quality and efficiency traits; to ensure that data collection and analysis systems provide the necessary genetic information with the minimum of confusion; to use that information to improve beef cattle breeds to allow quality beef to be more efficiently produced; and to facilitate the exchange of genetic material on a global scale.

These challenges face all beef producing countries. Unresolved, they are major impediments to efficient production, product quality and beef industry competitiveness. Since existing structures and future needs are different, solutions also will differ. But there is much we can learn and apply in common.