GENETIC IMPROVEMENT IN URUGUAYAN BEEF AND DAIRY CATTLE POPULATIONS[1]

Jorge I. Urioste

Depto. Producción Animal y Pasturas, Facultad de Agronomía, Universidad de la República – Av. Garzón 780, 12900 Montevideo, Uruguay

1. Introduction

The aim of selection programs in animal populations is to maximize the rate of genetic gain in traits considered of economic importance. Since genetic merit of animals (e.g. Breeding Values, Predicted Transmitting Ability, Expected Progeny Difference) is not observable, such programs are based on inferences from field data, containing information from the own candidates and/or their relatives.

A general strategy to develop selection programs consists of the following steps (Ponzoni 1992): (i) definition of selection or breeding objectives, those traits of economic importance; (ii) choice of selection criteria, the measures to be taken in order to genetically evaluate the animals; (iii) organization of a recording scheme and genetic evaluation service; (iv) use of information to take selection decisions; (v) use of the selected animals.

In Uruguay, selection programs including national genetic evaluation across herds are of very recent data (early 1990's), and comprise the Aberdeen Angus, Hereford and Holstein breeds. The objective of this paper is to present the main applications of general principles of animal breeding in Uruguayan beef and dairy cattle populations, following the steps mentioned above.

2. Breeding objectives

The definition of breeding objectives should be the primary step in the development of national breeding programs (Harris et al. 1984). Breeding objectives stipulate the animal characteristics to be improved and the desired direction for genetic change (Kinghorn and Simm 1999). They are generally expressed as economic weightings, which describe the economic impact of a unit change in each trait of commercial importance. Breeding objective traits are not necessarily the same as the selection criterion, traits that are measured and used to make selection decisions. For example, feed intake may be a breeding objective and body weight a selection criterion. Knowing the genetic relationship between these two traits allows us to improve the former, using data on the latter.

Ponzoni and Newman (1989) described the methodology to be used for definition of breeding objectives in terms of four phases: (i) Specification of breeding, production and marketing systems. (ii) Identification of sources of income and expense in commercial herds; (iii) Determination of biological traits influencing income and expense. (iv) Derivation of economic value of each trait.

Applying this procedure, Urioste et al. (1998) identified four main production systems for beef cattle in Uruguay, which are presented in Table 1. Systems 1 to 4 are increasing in inputs. System 1 corresponds to a traditional, extensive system based on native pastures and a low level of husbandry. System 2 makes a strategic use of improved pastures. System 3 has two specialized phases: the cow-calf operation on native pastures but with good management practices, and the fattening operation, with a high percentage of improved pastures. System 4 is similar to System 3 but using a terminal sire breed after the 3rd. calving.

Biological traits influencing income and expenses included growth (sale live weight in young and adult cattle), reproduction (weaning rate), calving ease (direct and maternal expressions) and feed intake (feed intake in adult and young cattle during winter) traits.

[1] Symposium "Genetics of Bovines"

Table 1. Main features of four pasture based Uruguayan beef cattle production systems (Urioste et al. 1998)

	System 1	System 2	System 3	System 4
Feeding	100% native pasture (np)	15% improved pasture (ip)	Breeding: 100% np Finishing: 40% ip	
Breeds	British	British	British	British; crosses after 3rd. calving
Heifer mating age (years)	3	2	2	2
Weaning rate (%)	64	70	74	74
Autumn sale, steers				
Age (years)	4.5	3.5	2.5	2.5
Weight (kg)	510	470	440	520 (crossbred)
Spring sale, steers				
Age (years)	-	3	2	2
Weight (kg)	-	450	420	420 (purebred) 480 (crossbred)

The economic-genetic variation of the trait groups is showed in Figure 1. The high economic value of weaning rate (WR) was important. They showed that substantial emphasis can be justified for beef cattle reproduction traits. Feed costs represent a major expense in most beef cattle enterprises. Ignoring them has important consequences, leading to higher live weight and increased feed intake (Urioste et al. 1998). Calving ease (CE) represented 25-50% of that of growth.

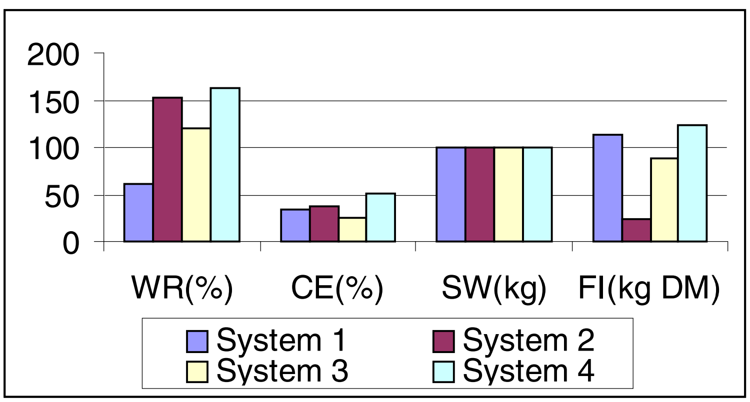

Figure 1. Economic-genetic variation (|economic value x additive genetic standard deviation|) for the trait groups in the breeding objective, expressed relative to growth-group traits, within each production system (adapted from Urioste et al. 1998).

The same kind of study has not yet been achieved in dairy cattle. However, milk, fat and protein yields are the main components of dairy farmer's income and therefore the most important traits to be improved. Other traits commonly included in breeding objectives are health, fertility, calving ease, body weight, feed intake, length of herd life (Goddard and Wiggans 1999)

3. Selection criteria

The development of breeding objectives involves making decisions of an economic nature, with little regard to the genetic consequences. Genetic considerations become relevant when we attempt a genetic evaluation of the animals. Some traits in the breeding objective may be difficult or expensive to measure (e.g. feed intake), whereas there may be characters easily measured and highly correlated genetically with the traits in the objective, but that are not themselves included in it. Defined selection criteria for Uruguayan beef cattle are different weights (birth, weaning, 15 and 18 month weights), and more recently, scrotal circumference. Urioste et al. (1998) showed that including simple reproductive measures in the genetic evaluation of animals, such as scrotal circumference and calving day, increased the genetic gain expressed in economic units. In dairy cattle, traits recorded are milk and fat yield, being protein and somatic cell counts recently incorporated. Type (conformation) traits are also recorded by the Uruguayan Holstein Breeders Society.

4. Recording and genetic evaluation schemes

Recording schemes have been developed by the producers' organizations, in the Aberdeen Angus case with initial support from the University. Genetic evaluation procedures have remained the responsibility of institutions with the necessary technical ability (the University for Aberdeen Angus and Holstein, and the Instituto Nacional de Investigación Agropecuaria, INIA, for Hereford).

The goal of a genetic evaluation system is to produce rankings of animals that will enable genetic progress in the traits included in the breeding objective, when selection decisions are made based on the rankings. National evaluation programs developed rapidly in the world after the arrival of the Best Linear Unbiased Prediction methodology (Henderson 1973; 1984). Each country has adapted its evaluation system to model the structure of its data and computational resources. Definitions include e.g. parameter estimates, definitions of contemporary groups, other fixed environmental effects such as age of the animal and reporting scale of evaluations. BLUP predicts breeding values and accounts for fixed environmental effects simultaneously (e.g. herds, years, seasons, ages, etc.). This means that animals can be compared across groups, giving wider scope for selection. As an example, a review of international practice in dairy genetic evaluation can be found in Interbull (2000).

In Uruguay, animal models based on BLUP methodology are used both in beef and dairy cattle. Breeds with National Across-Herds Genetic Evaluation Programs are the Aberdeen Angus, Hereford and Holstein. These applications are of recent data, aiming to offer beef and dairy producers estimation of their animals' genetic merit.

An animal model allows consideration of all genetic relationships among animals and results in simultaneous evaluation of cows, bulls and calves. Genetic parameters are assumed known. In practice, they are previously estimated (Saavedra and Urioste, 1995,1996a, b; Urioste, 2000). Fixed effects have been studied by Rovere et al. (1996) and Fernandez et al. (1996) for beef cattle and Ravagnolo et al. (1996) and Berger et al (2000) for dairy cattle. Table 2 illustrates, for the Aberdeen Angus case, the implementation of this knowledge in the breed's genetic evaluation.

Table 2. Main features of the Aberdeen Angus genetic evaluation

Trait definition and units	Birth weight (BW), Weaning Weight, direct (WWd), weaning weight, maternal (WWm), weight at 18 months (W18). Units: in kg
Genetic parameters	Heritabilities: BW=WWd=0.35; WWm=0.25; W18=0.4; Genetic correlations between BW, WWd and W18=0.45-0.5; genetic correlations between WWd and WWm=-0.1
Genetic evaluation model	Multivariate animal model Fixed effects: herd-year-season-management group; sex of calf; age of dam. All measured traits have an animal genetic effect. Weaning weight presents also a maternal genetic effect.
Use of genetic groups and additive relationship matrix	Six genetic groups (genetic subpopulations) are considered, depending on sex of parents and genetic origin (imported, national pedigree or grade animals). Additive relationship matrix with animal, sire and dam is used.
Expression of genetic evaluation	Expected Progeny Difference
Genetic reference base	Fixed: average of animals born in 1988

Population size differs between breeds, and measurements have characteristics peculiar to production systems. At any rate, records allow to predict genetic merit of far more animals than those being measured (Table 3). This is possible by use of the additive relationship matrix, which describes the predicted number of alleles per locus shared by descent between each pair of animals. Information from all relatives is simultaneously handled, and all animals genetically linked with an animal with records will receive a prediction of their genetic merit.

Table 3. Number of records for different traits and animals evaluated in Aberdeen Angus and Holstein populations in 1999

	Aberdeen Angus	Holstein
Records[1]		
	BW= 10,157 **WW=10,500** **W18=3,419**	**M305= 148,777 lactations**
Animals evaluated		
bulls	**1,034**	**2,603**
cows	**10,674**	**201,245**
calves	**26,983**	
Genetic trends		
% of the mean	**0.3 - 0.4**	**0.2**

[1] BW: birth weight; WW; weaning weight; W18: weight at 18 months; M305: milk yield at 305 days

5. Use of information and selected animals

Sire Summaries and cow and calf rankings for each herd are lists of genetic predictions for helping producers to make genetic decisions. Typically, summaries present animals' identity, their genetic merit (PTA, EPD) and measures of the reliability of the estimations (number of herds, number of offspring, accuracy or repeatability). Extension work in this area is an important task for the near future. Widespread use of artificial insemination (both national and imported semen) facilitates the genetic links needed for evaluations across herds and disseminates the genetic progress achieved.

6. Conclusions

Genetic improvement in developing nations tend to follow the progress in developed countries, with a certain lag, depending on the speed of technology transfer, limitations in resources and organization. That is also the case of Uruguay. A crucial point for our countries is that of correctly defining breeding objectives adapted to our production systems. The main purpose of livestock breeding schemes is to improve the production of healthy, tasteful and cheap animal products of benefit for both producers and consumers. Without clear objectives, uncritical adoption of new methodologies or inclusion of new genetic resources may lead to a worsened relationship between benefit and costs, or even to unexpected failures, thus not achieving our goals.

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