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Carcass attributes in breeding objectives and selection criteria for british breeds in Uruguay

Características de la res en objetivos y criterios de selección para razas británicas en el Uruguay

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Abstract

This study considered the inclusion of carcass attributes in breeding objectives and selection criteria developed for pasture-fed Uruguayan production systems for beef cattle, based on British breeds. Correlated responses in dressing percentage (DP), eye rib area (ERA) and dorsal fat depth (DFD) were determined, when these traits are not formally included in the breeding objective. Addition of DP in the breeding objective, which also included growth, reproduction and feed intake traits, was studied. Genetic change in each trait when using selection indices that included growth (G), growth plus reproduction (GR) and growth plus reproduction plus carcass measures (GRC, where ERA and DFD were obtained by ultrasound techniques) was evaluated. The correlated response in carcass traits when they were not included in the breeding objective was insignificant or very small. When included in the breeding objective, DP showed the lowest economic-genetic importance in relation to other growth, reproduction and feed intake traits. Index GR showed a genetic gain of 94% over that produced by index G, whereas index GRC only showed a superiority of 16% over index GR. Carcass attributes are not expected to deteriorate, even when they were not included in the breeding objective. Inclusion of DP as the only carcass trait in the objective is of secondary importance in beef cattle selection.

Keywords: beff cattle, breeding objectives, selection indexes, carcass traits, British breeds

Resumen

Este estudio consideró la inclusión de características de la res en objetivos y criterios de selección derivados para algunos sistemas pastoriles de producción de carne vacuna en Uruguay, basados en razas británicas. se determinó la respuesta correlacionada en rendimiento de carcasa (RC), área del ojo del bife (AOB) y espesor de grasa dorsal (EGD) cuando estos rasgos no están incorporados formalmente al objetivo de selección. Se estudió la inclusión de RC en el objetivo, que además consideró rasgos de crecimiento, reproducción y consumo de alimento. Se evaluó el cambio genético en cada rasgo, utilizando índices que incluían características de crecimiento (C), crecimiento más reproducción (CR) o crecimiento más reproducción más res (CRR, donde AOB y EGD son mediciones obtenidas por ultrasonografía). La respuesta correlacionada en característica de la res cuando no son incluidas en el objetivo fue nula o muy pequeña. Cuando se incluyó RC en el objetivo, su importancia económica-genética fue la de menor relevancia, en relación a rasgos de crecimiento, reproducción y consumo. El índice CR produjo una ganancia genética de 94% sobre la producida por el índice C, mientras que el índice CRR sólo mostró una superioridad del 16% sobre el índice CR. No es previsible un deterioro genético en características de la res, aunque no sean incluidas en el objetivo de la selección. La inclusión de RC como único rasgo de carcasa parece ser de importancia secundaria en la selección de vacunos de carne.

Palabras clave: bovinos de carne, objetivos de selección, índices de selección, características de res, razas británicas

INTRODUCTION

One of the main goals in the definition of selection objectives is the establishment of an adequate weighting in the selection emphasis applied to different biological traits. A previous study (Urioste and others, 1998) examined aspects of growth, reproduction, ease of delivery and intake for meat production systems in Uruguay. Other research (Amer and others, 1997, 2001; Barwick and Henzell, 1999; Hirooka and others, 1998; Phocas and others, 1998; Ponzoni and Newman, 1989) has included carcass attributes in both the objectives and selection criteria. However, these authors admit that the results obtained depend, to a large extent, on the genetic parameters and economic assumptions made. Newman and others (1992) do not include carcass traits in their study because producers do not receive bonuses for leaner carcasses. A similar problem to the latter occurs with the carcass attributes in Uruguayan conditions, where, at the time of this study, definitions of buyer markets with detailed specifications of required quality were not available. In general, scales do not include differential prices, and information on carcass attributes is much scarcer than on the features mentioned above.

This study aimed to present initial studies on the consideration of carcass characteristics in the objective and selection criteria, for some of the systems previously defined in the study of Urioste and others (1998), considering, in particular, the situation of multipurpose breeds such as Aberdeen Angus and Hereford. In a later article, considerations are made about the importance of the carcass attributes for terminal breeds.

MATERIAL AND METHODS

The studies were carried out on three of the four meat production systems investigated by Urioste and others (1998). The methodology and genetic parameters used are extensively described in the aforementioned study. Briefly, System 1 corresponds to a traditional, extensive system, based exclusively on natural pastures and a low level of management. Steers and old cows are sold in the fall. System 2 makes strategic use of improved pastures (15% of the total grazing area), thus obtaining better productivity than System 1. Half of the steers are sold at 3 years in spring (off-season), and the other half are sold 6 months later.

System 3 has two distinct phases:

a) breeding, on natural pastures, with good management, selling all steers, culling heifers and replacement cows in fall; b) fattening, with a high percentage of improved pastures, buying weaned calves and selling 2-year (70%) and 2.5-year (30%) steers. Grazing was the feeding system assumed in all cases, throughout the year. A multipurpose British breed, such as Aberdeen Angus or Hereford, was assumed as the genetic basis.

Figure 1 illustrates the herd composition for System 3. Corresponding values for the other systems can be found in Urioste and others (1998). This information is required to identify the herd's age structure, the restocking and marketable number of animals each year. It is also used for the calculation of discounted expressions of each trait, since not all traits are expressed at the same time or with the same frequency. The economic value (EV) of the biological traits that influence the income and/or costs of the agricultural company was derived from an economic profit equation (P). EVs were calculated as the change in P resulting from a change unit of the trait in question, assuming that all other traits remain constant. Profit is defined as the difference between income and expenses. This approach (Ponzoni and Newman, 1989; Newman and others, 1992) allows ignoring fixed production costs. The traits considered, grouped into categories, are listed in Table 1.

"Discounted gene flow" techniques (McClintock and Cunningham, 1974) were applied in the calculation of EVs to account for the fact that not all traits are expressed at the same time or with the same frequency. In the case of multipurpose breeds, expressions for each trait were calculated for 20 years and all generations in which the trait was expressed within that period, using a discount rate of 5%.

All EVs were expressed in US dollars for a herd of 100 breeding cows. In order for the economic values - expressed in monetary terms per unit of the trait in question - to be comparable, they must be expressed in a common unit. A generally used procedure for this purpose, is to take the absolute value of the economic value by the additive genetic standard deviation of the trait in question (Ponzoni, 1992; Barwick and others, 1994).

Figure 1. Herd composition for System 3.

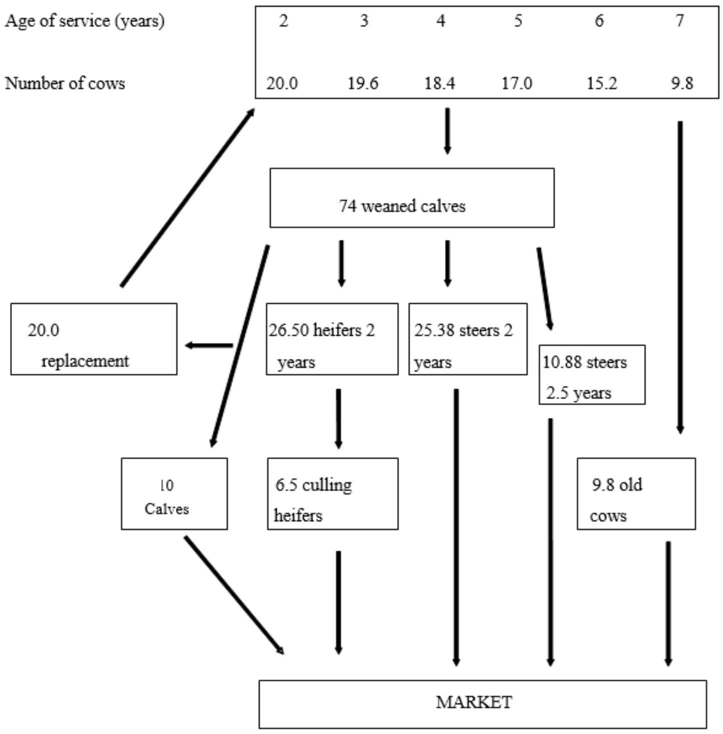

Table 1. Biological traits that affect profit.

Trait Group	Biological Traits
Reproduction	Weaning rate (WR), %
Calving ease	Calving ease, direct (CEd), %
	Calving ease, maternal (CEm), %
Growth	Sale weight, young animals (SWy), kg
	Sale weight, cow (SWc), kg
Intake	Feed intake, winter period:
	young animals (Iy), kg dry matter cows (Ic), kg dry matter
Carcass	Dressing percentage (DP), %

The absolute value of the last expression (|EV| x σ_A) allows the comparison of traits in terms of the "economic-genetic variation" (EGV) available.

Table 2 shows the characteristics chosen as possible selection criteria, and the information of relatives assumed to be available for the analysis of the selection consequences. These characteristics were chosen because their registration is possible within current record collection systems and because of their genetic correlations with traits in the selection objective.

Ultrasonography measures, while not in widespread use, are possible to implement in the near future.

The genetic and phenotypic heritabilities and correlations assumed between traits (selection objective) and characteristics (selection criteria) were chosen after a literature search (Koots and others, 1994a,b; Nitter and others, 1994; Ponzoni and Newman, 1989; MacNeil and Newman, 1994; Mohiuddin, 1993). The resulting matrices of variances and covariances were tested for "permissibility" (Foulley and Ollivier, 1986) and satisfied all the necessary conditions.

Table 2. Characteristics chosen as selection criteria.

Selection Criteria	Candidate	Father	Mother
Calving Day, Days (CD)			x[1]
Calving ease, % (CE)			x[2]
Scrotal circumference, cm (SC)	x	x	
Birthweight, kg (BW)	x	x	x
Weaning weight, kg (WW)	x	x	x
Weight at 18 months, kg (W18)	x	x	x
Eye rib area (ultrasonography), mm^2 (ERA)	x	x	x
Dorsal fat depth (ultrasonography), mm (DFD)	x	x	x

[1]3 records; [2]recorded as heifer.

Detailed information can be found in Urioste and others (1998). In particular, the heritabilities of dressing percentage (DP), dorsal fat depth (DFD) and eye rib area (ERA) were 0.3, 0.4 and 0.4, respectively. DP is not genetically correlated with reproductive or growth traits, but a correlation of +0.2 with DFD and ERA is assumed. DFD has low genetic correlations (+0.1) with growth characteristics, and somewhat higher (+0.2) with ERA and intake traits. Finally, ERA presents increasing correlation values (from +0.15 with birthweight to +0.4 with final weight) with growth characteristics.

Investigated situations

Two relevant situations analyzed here were:

A study of the correlated response of carcass traits in the most common production systems in Uruguay (Systems 1 and 2, Urioste and others, 1998) when these are not formally included in the objective. It is assumed for the aforementioned systems (extensive and semi-extensive, respectively), that the carcass traits have no economic value, but there is an interest to see how these modify with different definitions of objectives and selection criteria.

The inclusion of dressing percentage (DP) in the selection objective of a more intensive production system, with specialized breeding and fattening phases, using a British breed (System 3). The economic value (EV) and the economic-genetic variation (EGV) of DP were calculated. Its value was assumed to come from the price of the kg contained in each additional 1% increase in performance. The average assumed performance was 53.5%

As selection criteria for DP, dorsal fat depth (DFD) and eye rib area (ERA) were used, obtained by ultrasonography. Phenotypic and genetic correlations of 0.8 were assumed between the same measures taken in the carcass and the live animal. Three selection indices were compared, in order to study the consequences of incorporating carcass measures in the genetic evaluation of animals for which complete selection objectives have been defined, including DP. The G (growth) index included records of live weight in the individual at birth (BW), weaning (WW) and 18 months (W18), already existing in the National Systems of record collection. A second index, the GR index (growth plus reproduction) included the same criteria, as well as the reproductive records of scrotal circumference (SC) in the individual candidate for selection and calving day (CD) (3 measures in the individual's mother).

The GRC index (growth plus reproduction plus carcass attributes) covered all measures included in GR and added measures of dorsal fat depth (DFD) and eye rib area (ERA) taken by ultrasonography in the individual candidate for selection.

For each of the situations studied, the selection rates were evaluated using the SELIND program (Cunningham and Mahon, 1977). To calculate genetic gains over 10 years, a selection intensity/generational interval ratio of 0.21 (5% of selected bulls, unselected cows, and generational intervals of 6 and 3.6 years for cows and bulls, respectively) was assumed. The cumulative economic profit (CEP) over 10 years was a measure of total economic gain for each system.

RESULTS

The EV obtained for DP was 165.8 USD per 1% for a hypothetical herd of 100 cows. To establish some kind of comparison with other groups of traits, DP was expressed in terms of relative importance to the economic genetic variation (EGV) of growth traits. DP was the least relevant attribute within the objective, with a EGV of 18.5 compared to 100, 26, 120 and 87.9 for growth, calving ease, reproduction and intake, respectively, obtained for this same System by Urioste and others (1998).

Table 3 shows the magnitude of the correlated response in Systems 1 and 2, when selected over 10 years by objectives that do not take into account the carcass attributes. The results show little or no variation, regardless of the production system and the defined objective.

Table 4 presents the percentage contribution to the genetic response of different groups of biological traits and the economic profit produced by the use of each index.

Table 3. Correlated response in 10 years in carcass traits, selecting by a complete objective or by weight at 18 months.

Traits	System 1: Traditional Full Cycle		System 2: Improved Full Cycle	
	Full Objective	Weight at 18 months	Full Objective	Weight at 18 months
Performance (%)	0	0	0	0
Dorsal fat depth (mm)	-0.2	0.5	0.2	0.5
Área Ojo del Bife (cm^2)	0.4	2.3	1.7	2.3

Table 4. Genetic change in 10 years for each trait, total gain in 10 years (USD) and percentage contribution to the genetic gain of each trait group, using G, GR and GRC indices.

Traits	G Index	GR Index	GRC Index
Genetic change			
WR (%)	0.7	3.7	3.2
CEd (%)	-3.0	-1.0	-0.9
CEm (%)	0.6	0.8	0.6
SWy (kg)	18.8	11.6	14.6
SWc (kg)	15.0	9.3	11.7
Gy (kg DM)	10.2	2.6	0.9
Gc (kg DM)	19.1	4.1	-0.2
DP (%)	0	0	0.2
ERA (mm^2)	2.1	0.9	4.0
DFD (mm)	0.1	0	0.3
Contribution to genetic response (%)			
Growth	153.4	49.5	54.0
Reproduction	20.6	58.4	44.0
Calving ease	-7.0	-0.1	-0.2
Intake	-67.2	-7.8	-0.4
Carcass	0	0	2.6
Economic profit in 10 years	2004.2	3833.3	4438.8

Index G: individual weights (at birth, weaning and 18 months).
GR Index: G index + individual scrotal circumference + calving day in mother (3 records). GRC Index: GR index + dorsal fat depth and eye rib area in the individual.
Other symbols as in Tables 1 and 2.

The genetic gain of the GR index expressed as cumulative economic profit over 10 years, represents a percentual improvement over the G index of 94%, while the GRC index only shows superiority of 16% over the GR index. The relative contribution of GR to genetic gain was zero for the G and GR indices, and very low for the GRC index. In the G index, the greatest contribution is made by growth, counterbalanced by a very negative effect caused by the intake increase.

In the GR and GRC indices, the relative contribution of growth and reproduction tends to be similar. With the G index, total genetic gain was mainly explained by increases in SWy and SWc, accompanied by unfavorable changes in intake traits and calving ease, and negligible changes in WR. With the GR index, the different groups of traits contributed in a more balanced way to the total response. There was a shift towards a greater genetic response in WR, and a reduction in negative genetic tendencies in CE and G. The genetic change in growth traits also decreased. With the GRC index, the genetic change in carcass attributes turned positive, while progress in growth traits was intermediate compared to the other indices, the weaning rate was similar to that of the GR index and intake was practically unchanged.

DISCUSSION

The current price system in Uruguay does not yet systematically consider variations in performance, subcutaneous fat depth or other measures related to carcass attributes. The developed model allows studying a wide range of scenarios, from which two situations were chosen. The first situation investigated, did not formally include carcass attributes in the selection objective, due to the difficulty to assign it an economic value. Table 3 shows extremely moderate genetic changes in carcass attributes against various production systems and selection strategies. These results are important because they establish a solid starting point for the study of carcass attributes in the British breeds that constitute the majority of the beef cattle population in Uruguay.

While traits related to carcass quality cannot improve substantially if they are ignored in the objective, a deterioration of their genetic level in these breeds is also not foreseeable, regardless of the selection policy applied.

In the second situation analyzed, the inclusion of carcass traits both in the objective and in the selection criteria improved the economic result, but the percentage leap achieved was much smaller, compared to the inclusion of fertility measures. In general, several studies (Barwick and others, 1994; Graser and others, 1994; Nitter and others, 1994; MacNeil and others, 1994; Phocas and others, 1998) give a greater relative importance to reproductive traits, followed by growth and carcass traits. The low contribution of carcass traits in the present study seems to be linked to the absence of genetic correlations with other traits and their low genetic variability, added to the difficulty of precisely defining the economic value of the traits considered. The relative importance of DP in the objective, lower than 20%, places it as the least important trait in the selection objective. Other authors (Ponzoni and Newman, 1989; Nitter and others 1994; Barwick and others 1994) reported an economic-genetic variation of carcass traits between 26 and 72% of that of growth. For Hirooka and others (1998), meat marbling was the most important trait to improve economic profit through the selection of meat cattle in Japan. Australian researchers (Barwick and Henzell 1999) proposed a method to calculate EV for the marbling, but warn about the scarcity of existing information and the strong conditioning that the study assumptions (genetic parameters, production systems, marbling level) exert on the final result.

European Studies (Amer and others, 1997, 2001; Phocas and others, 1998) focus on weight measures and scales of carcass conformation and fat cover. The results show great variability, depending on the animals' genotype, production systems, feed price and system of penalties in carcass price. MacNeil and others (1994) suggest the need for systematic and long-term development of productive and economic records at the level of commercial producer.

CONCLUSIONS

Genetic deterioration in carcass attributes is not foreseeable in the country's multipurpose breeds, even if they are not specifically included in a selection objective. The inclusion of GR as the only carcass trait seems to be of secondary importance in the selection of beef cattle, compared to growth and reproduction, for a system as the one defined in this study.

Meat quality measures deserve further study in the future, covering a wider range of production and marketing systems, as well as more precise biological descriptions of the characteristics of interest.

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