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# Association between genetic evaluation and show-ring judging for dairy and beef cattle¤

***Asociación entre la evaluación genética y el juzgamiento en pista de bovinos lecheros y de carne***

***Associação entre a avaliação genética e a aparência externa na pista de julgamento de bovinos de leite e de corte***

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**Summary**

**Background:** a concern for breeders is whether an animal ranking based on genetic evaluations is similar to that obtained from show-ring judging. **Objective:** to determine the association between rankings for Braunvieh (BR) and Brown Swiss (BS) cattle of Mexico based on show-ring judging and their respective expected progeny differences (EPDs) or predicted transmitted abilities (PTAs). **Methods:** ranking values from judging were transformed using the rankit transformation. For each breed, Pearson correlation analyses were performed between the transformed rank values of the animals obtained from judging at the show-ring and their EPD or PTA values. **Results:** using the complete databases, in both breeds the correlation coefficient estimates were low (<0.18) but different from zero ($p<0.05$). The correlation coefficient considering PTAs for milk yield in BS was slightly higher than those obtained for any EPD for growth traits in BR. Correlations in adult animals (0.18 to 0.23) were different from zero ($p<0.05$) and higher than those of young animals or calves, while those within males or females were similar. Correlations within years of judging in the show-ring were variable and did not indicate any specific trend. **Conclusions:** show-ring rank results are associated with genetic evaluation of animals, although the magnitude is low. Selection of breeding animals based on show-ring judgment could be used as a complementary tool to genetic evaluation.

**Keywords:** *auction show, expected progeny differences, predicted transmitted abilities, rankit transformation*.

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**Resumen**

**Antecedentes:** una preocupación de los criadores es si la jerarquización de los animales basada en evaluaciones genéticas es similar a la del juzgamiento en la pista. **Objetivo:** determinar la asociación entre la jerarquización de animales con base en el juzgamiento en pista y sus respectivas diferencias esperadas en la progenie (EPDs) o habilidades de transmisión predicha (PTAs), para animales Pardo Suizo Europeo (BR) y Americano (BS) de México. **Métodos:** los valores jerárquicos del juzgamiento fueron transformados usando la transformación rankit. Para cada raza, análisis de correlación de Pearson fueron realizados entre los valores jerárquicos transformados de los animales obtenidos del juzgamiento en la pista y sus valores de EPD o PTA. **Resultados:** usando las bases de datos completas, en ambas razas los coeficientes de correlación estimados fueron bajos (<0,18) y diferentes de cero (p<0,05). El coeficiente de correlación considerando las PTAs para producción de leche en BS fue ligeramente mayor que los obtenidos con cualquier EPD de las características de crecimiento en BR. Las correlaciones en animales adultos (0,18 a 0,23) fueron diferentes de cero (p<0,05) y mayores que las de animales jóvenes o becerros; mientras que para hembras y machos fueron similares. Correlaciones por año de juzgamiento en pista fueron variables y sin tendencia específica. **Conclusiones:** la jerarquización de animales usando los resultados de juzgamiento en la pista y las evaluaciones genéticas están asociadas pero en baja magnitud. La selección de animales con base en su juzgamiento en pista puede usarse como herramienta complementaria a la evaluación genética.

**Palabras clave:** *diferencias esperadas en la progenie, habilidades de transmisión predichas, subasta, transformación rankit*.

**Resumo**

**Antecedentes:** uma preocupação dos criadores é se a classificação dos animais baseada em avaliações genéticas é similar na pista de julgamento. **Objetivo:** determinar a associação entre a classificação de animais baseada no julgamento em pista e suas respectivas diferenças esperadas na progênie (EDPs) o habilidades de transmissão preditas (PTAs), para as animais Braunvieh (BR) e Brown Swiss (BS) do México. **Métodos:** os valores de classificação dos animais durante o julgamento foram transformados por meio da metodologia rankit. Para cada raça, análises de correlação de Pearson foram realizadas entre os valores de classificação transformados obtidos pela avaliação na pista de julgamento e seus valores de EPD o PTA. **Resultados:** usando a base de dados completa, em ambas as raças os coeficientes de correlação foram baixos (<0,18) e diferentes de zero (p<0,05). O coeficiente de correlação considerando as PTAs para produção de leite na BS foi ligeiramente maior que os obtidos com qualquer EPD das características de crescimento na BR. Correlações em animais adultos (0,18 a 0,23) foram diferentes de zero (p<0,05) e mais elevadas do que aquelas de animais jovens ou bezerros; enquanto que para as fêmeas e os machos foram semelhantes. Correlações por anos na pista de julgamento foram variáveis e sem tendência específica. **Conclusões:** a classificação de animais usando os resultados na pista de julgamento e as avaliações genéticas estão associadas, mas em baixa magnitude. A seleção de animais baseada nos resultados na pista de julgamento pode usar-se apenas como ferramenta complementar à avaliação genética.

**Palavras chave**: *diferenças esperadas na progênie, habilidades de transmissão preditas, leilão, transformação rankit.*

## Introduction

Selection of breeding animals is important to increase farm production and productivity. In cattle, genetic evaluation (GE) and judgment of the breed standard in the show-ring (JUD) are tools to measure the success of breeders in their selection strategies. JUD uses a subjective comparison attending the external appearance of animals and trained judges determine the ranking based on a set of visual characteristics. This type of selection is accepted and used by a number of breeders and producers under the assumption that functional traits in animals are related with their own and progeny performance. On the other hand, GE uses an objective comparison through predicted breeding values, which are generally expressed as expected progeny differences (EPD) for beef cattle and predicted transmitted abilities (PTA) for dairy cattle. This selection tool is accepted worldwide and used to achieve genetic progress. Predicted values are commonly obtained through the use of animal model BLUP (best linear unbiased prediction) procedures.

According to Madalena (2005), selection of cattle in most Latin-America countries used to be based on type and show-ring results. Nevertheless, since the 1970s, GE has been applied in several countries and its influence is steadily increasing. Published information on estimates of the association between both ways of breeding selection is scarce. Some authors consider little or no relationship exists between rank results by JUD and GE (Boostrom *et al*., 1986; Madalena *et al*., 2002; Rocha *et al*., 2006).

Mexican cattle breeders members of the Asociación Mexicana de Criadores de Ganado Suizo de Registro (AMCGSR) have been comparing their animals in national JUD to determine the best Braunvieh and Brown Swiss breeders for a number of years. Likewise, since 2003 they have carried out national GE. Braunvieh and Brown Swiss cattle breeds are commonly used in commercial herds for beef and milk production under several systems and climates in Mexico (Estrada-León *et al*., 2008; Saavedra-Jiménez *et al*., 2013). A concern for Mexican breeders is whether the ranking of the animals based on GE is similar to that based on JUD. Thus, the objective of this study was to determine the degree of association between animal rankings based on conformation (JUD) and their respective EPD or PTA values for registered Braunvieh and Brown Swiss cattle in Mexico.

## Materials and methods

### *Data origin*

Place rankings in JUD from several places in Mexico during six years of Braunvieh and Brown Swiss national show-ring competitions (2003, 2004, 2005, 2006, 2009, and 2010) were provided by the Asociación Mexicana de Criadores de Ganado Suizo de Registro (AMCGSR). Professional judges from the United States of America judged animals of the same gender and age for each year and breed through visual assessment during traditional animal shows in Mexico. The judging procedure during the show-ring involves selecting the animals that better match the breed pattern (including attributes such us head, feet, hair color, horns, udder, etc.). Once a group of animals enter the ring, the judge verifies carefully each animal based on its breed pattern. Then the judge ranks animals beginning with the one that best fit the ideal pattern, and the other animals follow until the last in the ranking is assigned to the one with the worst fit. Evaluation of the attributes is done simultaneously, without assigning specific scores; that is, the judge only provides the subjective ranking positions. The total number of animals evaluated for Braunvieh and Brown Swiss were 735 (467 females and 268 males) and 648 (454 females and 194 males), respectively. Originally there were 22 age groups for females and 16 for males; however, in this study they are presented in three categories: calf (6 to 15 months of age), young (16 to 39 months of age), and adult (> 39 months of age). The annual mean of the number of animals ranked according to age group in Braunvieh oscillated between 3.3 and 5.9 (minimum 2, to maximum 14), and from 3.1 to 6.5 in Brown Swiss (minimum 2, to maximum 16).

Animals participating in JUD competitions also had results from the national GE in Mexico. For Braunvieh cattle, individual EPD values of direct and maternal weaning (adjusted to 240 d) and direct yearling (adjusted to 365 d) weights were used; while for Brown Swiss, individual PTA values of milk yield adjusted to 210 d were considered. In the present study, GE was carried out using national performance records collected until year 2010. The MTDFREML (USDA, Clay Center, NE, USA) free software, developed at the US Agricultural Research Service (Boldman *et al*., 1995), was used to predict breeding values (EPDs or PTAs).

A bivariate animal model (weaning and yearling weights) that considered contemporary groups formed by year and birth season, herd and sex of the calf, and the linear and quadratic effects of dam age at calving as fixed effects were used for Braunvieh cattle. A single-trait repeatability animal model that considered herd-year-season and linear age of the cow and purebred level as fixed effects were used for the Brown Swiss genetic evaluation (most animals were purebred Brown Swiss but some were upgraded to 7/8, 15/16 and 31/32 levels). The number of animals used in the pedigrees was 137,343 and 122,216 for Braunvieh and Brown Swiss, respectively. Evaluation accuracy of EPDs oscillated for direct weaning weight between 13 and 88% (average = 46%), for maternal weaning weight between 10 and 57% (average = 33%), and for yearling weight from 12 to

87% (average = 49%). Reliability of milk yield PTAs fluctuated between 18 and 79% (average = 46%).

*Statistical analyses*

In order to consider group-size variability for animals ranked by JUD and to approximate normally distributed scores, the individual ranking values obtained were transformed using the rankit transformation, where the highest rankit was assigned to the animal in first place in its JUD evaluation group (Boostrom *et al*., 1986). According to Beasley *et al*. (2009), this is a rank-based inverse normal transformation that entails computing a new transformed value of the rank place score for the $i_{th}$ animal. Observed places are converted to estimate quantiles from the cumulative distribution function, and then these quantiles are converted to standard normal deviations using the inverse normal (or probit function). The approximation used was:

$$Y^t_i = \Phi^{-1} [(R_i - 3/8) / (N + 1/4)]$$

Where:

$Y^t_i$ = is the transformed value of the rank (rankit$_i$) for the $i_{th}$ animal.

$R_i$ = is the ordinary rank of the $i_{th}$ animal among $N$ number of animals graded in the corresponding evaluated group of the $i_{th}$ animal.

$\Phi^{-1}$ (.) = is the inverse of the standard normal distribution.

Within each breed, Pearson correlation analyses were performed between transformed rank values (rankits) by JUD and their corresponding EPD (Braunvieh) or PTA values (Brown Swiss) using the SAS software Statistical Analysis System User's Guide —Version 9.2—, SAS Institute Inc., Cary, NC, USA; 2009). Correlation coefficients were computed according to the total number of animals, year of judgment, gender, and age category to identify association-specific trends.

## Results

Pearson correlation coefficients (n = 735) between JUD and EPD values in Braunvieh for direct weaning weight, maternal weaning weight and yearling weight were 0.11, 0.10 and 0.12, respectively. Pearson correlation coefficient (n = 648) between JUD and PTA values in Brown Swiss for milk yield was 0.17. Correlation coefficient estimates were low (<0.18) but distinct from zero ($p<0.05$) for both breeds. Correlation coefficients between JUD and EPD or PTA values for males and females were similar in each of the breeds. In contrast, they presented different trends by JUD, when analyzed by year or category of age.

The findings by year using JUD and age category for the Braunvieh animals are presented in Table 1. Most of the correlation coefficients were not significantly different from zero ($p>0.05$). The estimated correlation values varied among years by JUD and age category. Correlation values varied among years (-0.07 to 0.21) and were significant in half of the years by JUD ($p<0.05$) in at least one of the JUD-EPD traits. Correlations within adult animals (0.18 to 0.23) were different from zero ($p<0.05$) and higher than those of young animals or calves. In young animals, coefficient correlations were consistently not different from zero ($p>0.05$) and included negative values.

The findings by year using JUD and age category for Brown Swiss animals are presented in Table 2. The estimated correlation values varied among years (0.06 to 0.25), and in half of those values the association between JUD and PTA values for milk yield were significant ($p<0.05$). Correlations in calf and adult animals (0.19 and 0.22, respectively) were different from zero ($p<0.05$).

## Discussion

For the complete databases, the findings show that ranking animals using JUD and GE results were favorably associated, but with low magnitude (Pearson correlation coefficients from 0.10 to 0.17), suggesting only some relationship between the two ways of evaluating animals. No published research in this regard was found for dairy cattle; however, the results of the present study were similar to those obtained in scarce previous studies on beef cattle. Using Hereford sires, Boostrom *et al*. (1986)

**Table 1.** Pearson correlation coefficients between rank judgment in the show-ring (JUD) and expected progeny differences (EPD) in Braunvieh cattle, by year using JUD and age category of the animals.

| Item | N | JUD - EPD traits[1] | | |
|---|---|---|---|---|
| | | JUD - $WW_d$ | JUD - $WW_m$ | JUD - YW |
| *Year by JUD* | | | | |
| 2003 | 119 | 0.16 | 0.09 | 0.19* |
| 2004 | 120 | 0.06 | 0.10 | 0.16 |
| 2005 | 125 | 0.07 | 0.06 | 0.15 |
| 2006 | 115 | 0.19* | 0.17 | 0.11 |
| 2009 | 114 | -0.02 | -0.07 | -0.05 |
| 2010 | 142 | 0.18* | 0.21* | 0.14 |
| *Age category* | | | | |
| Calf | 307 | 0.06 | 0.09 | 0.13* |
| Young | 173 | -0.02 | -0.06 | 0.00 |
| Adult | 255 | 0.23* | 0.19* | 0.18* |

[1]$WW_d$ = EPD for direct weaning weight; $WW_m$ = EPD for maternal weaning weight; YW = EPD for yearling weight.
*Correlation coefficients different from zero ($p<0.05$).

**Table 2.** Pearson correlation coefficients between rank judgment in the show-ring (JUD) and predicted transmitted abilities (PTA) for milk yield (MY) in Brown Swiss cattle, by year using JUD and age category of the animals.

| Breed/category | N | JUD - MY |
|---|---|---|
| *Year by JUD* | | |
| 2003 | 85 | 0.21 |
| 2004 | 136 | 0.21* |
| 2005 | 113 | 0.25* |
| 2006 | 97 | 0.06 |
| 2009 | 137 | 0.13 |
| 2010 | 80 | 0.25* |
| *Age category* | | |
| Calf | 277 | 0.19* |
| Young | 218 | 0.12 |
| Adult | 153 | 0.22* |

*Correlation coefficients different from zero ($p<0.05$).

estimated correlations between JUD and EPD values of direct weaning (0.16), maternal weaning (0.07) and yearling (0.10) weights. Rocha *et al*. (2006) estimated a significant correlation coefficient of 0.24 ($p<0.05$) between the 450 day weight EPDs of 71 Nellore sires and the mean scores of visual assessment in their progeny; however, they did not find correlations distinct from zero ($p>0.05$) when considering other growth or carcass EPDs. Simielli Filho *et al*. (2014) reported that high-ranking Nellore animals in JUD generally present higher breeding values for body weight, height, body length, and hearth girth.

The low associations between JUD and EPDs or PTAs were expected, since JUD procedures subjectively assess external phenotypic characteristics, while EPD or PTA values assess expected additive genetic performance differences in the progeny of animals for specific traits compared with other animals in GE. In theory, GE is a better way to select animals for genetic improvement. However, according to McHugh *et al*. (2012), studies have shown that some linear type traits (routinely scored and reflecting muscular, skeletal and functional characteristics) are useful indicators of profitability in dairy and beef animals. Guthrie and Majeskie (1997) reported that JUD initially was conducted in order to identify genetically superior animals for use as the parent stock of future generation; a score card was used to evaluate the physical traits related

to those of economic importance and to formulate logical reasons for placing dairy cattle at contests and shows. Using dairy Gir females in Brazil, Da Gama *et al*. (2014) reported a 0.21 heritability estimate for JUD, considering that the purpose of livestock judging was to promote harmony between economically important traits of animals that attend the national and international markets. Based on Bayesian inference under threshold analyses in Nellore cattle, Simielli Filho *et al*. (2014) estimated 0.18 and 0.26 heritabilities for two categorical definitions of ranking in JUD; in the first one, the success (value 1) indicated the animals (from first three ranking places) with the largest numbers of desired characteristics (such as weight, height, breed characteristics, beauty, etc.), and the failure (value 0) was assigned to the remaining animals in the category; and for the second definition, success was for the first five ranking places.

Based on the estimated heritability by JUD (0.35) in beef cattle, Boostrom *et al*. (1986) indicated that JUD is definitely not a random process (show-ring placing was highly correlated with height and moderately associated with weight, while scrotal circumference and backfat had little influence) and takes into account other important aspects, such as structural correctness of the animals, which are considered by buyers and influence the price. Visual assessment of breeding animals also helps to detect anatomic defects that could impair their normal reproductive performance. Thus, it can be inferred that selecting breeding animals based on JUD could be a complementary tool to strategies based on GE. In this regard, a number of studies have shown that EPD values influence price at traditional JUD and auction shows under several conditions (Chvosta *et al*., 2001; Paneto *et al*., 2009; Vestal *et al*., 2013), which means that EPD is taken into account when deciding to buy breeding animals in several places around the world. The relevant challenge is to incorporate that culture in developing countries.

In general, the results of the present study can be considered as a general indicator of the association between the two ways of selecting breeding animals. In Mexico, as in several Latin-American countries, it is well known that show-ring competitions give "prestige" to breeders and are still accepted and relied by producers, who buy and use animals because they are "champions" in a show-ring festival. Da Gama *et al*. (2014) mentioned that visual assessment started to seek the functionality of the animals in Brazil since the 1990s focusing on productive traits rather than breed characteristics, and show-ring winners are highly valued. Cattle championships influence germplasm commercialization and determine the direction of evolution within breeds as champions are rapidly disseminated (Simielli Filho *et al*., 2014). Thus, there is a need to advise and educate farmers to select breeding animals based on GE and use JUD as a complementary tool.

In this study, JUD-PTA correlations were slightly higher than JUD-EPD correlations, suggesting that significant details of external conformation in dairy animals could be associated in a better way with expected milk yield than with expected growth traits of their progeny; however, several other unknown factors could also be implied. When discussing the size of these correlations there is an implicit assumption in the sense that the selection objective for both GE and JUD are the same, and this may not be true. Probably JUD is more related to the evaluation of conformation traits associated to lifespan, which is different than the traits included in GE. Therefore, to reach definitive conclusions in this regard, more research is required under several conditions that show consistent results.

The similar correlation coefficients obtained when considering males or females suggest that details considered in the external conformation are independent of sex. This situation was also reported by Boostrom *et al*. (1986) in beef cattle.

Unfortunately, when decisions to select bulls are being made, the information available on differences of expected future progeny performance is often highly uncertain. A further problem with the use of JUD based on conformation traits is that judges could change the score or place given to the same animal (Schierenbeck *et al*., 2009). Thus, classifying animals in this way implies a certain degree of subjectivity. In the present study, the variability of correlations when analyzing within single years could indicate differences in the ability of judges to judge animals. To illustrate this idea, year 2009 results had negative correlations not different from zero ($p>0.05$) between

JUD and EPD for the three studied traits in Braunvieh beef cattle; also, the correlation between JUD and milk yield PTA was not different from zero ($p>0.05$) in Brown Swiss dairy cattle. In contrast, in year 2010 correlations were positive and of moderate magnitude, most of them distinct from zero ($p<0.05$) for EPDs and PTAs. On the other hand, EPDs or PTAs, even though they are objective, also have a certain degree of uncertainty (expressed by their accuracies) since those values are only predictors of true values. In this study, accuracy or reliability of those values was relatively low (averaging between 33 and 49%, depending on the trait).

The observed trend of correlation coefficients within a single age category suggests that JUD is better related with GE results in adults than in calves or young animals. This finding suggests that details in JUD are better appreciated when animals have reached full growth. This is in agreement with the study by Boligon *et al*. (2011), who mentioned that morphological traits could be better evaluated in yearlings due to genetic potential of the individual without interference from maternal effects.

In conclusion, ranking animals using show-ring results and national genetic evaluations are associated, but at low magnitude; therefore, selection of breeding animals based on show-ring judging could be used as a complementary tool to strategies based on genetic evaluations. Specific associations may be more reliable in dairy cattle than in beef cattle and in adult animals compared to calves and young animals.

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**Conflicts of interest**

The authors declare they have no conflicts of interest with regard to the work presented in this report.

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