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HERITABILITY OF BIRTH WEIGHT IN BHAGNARI AND ITS CROSSES WITH DROUGHTMASTER IN PAKISTAN

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Heritability was estimated in Bhagnari, Droughtmaster and their crossbreeds using 25 years data on birth weight records (1317 records from 27 sires) from Beef Production Research Center, Sibi, Balochistan (Pakistan). Birth weight averaged 24.52 ± 4.40 kg. The trait was moderately heritable when analysis was performed using data from all the genetic groups. The estimate varied from 0.257 to 0.381 with model used. When separate analyses were performed for different genetic groups such as Bhagnari (BN), Droughtmaster (DM), BN x DM (C_1), C_1 x BN (C_2) and C_2 x Droughtmaster (C_3), maximum heritability was observed for Droughtmaster (0.75) while it was minimum (0.08) for C_1 animals. In purebred Bhagnari, birth weight was only 13% heritable. Improper recording of birth weight, sire for the calf, and environmental factors such as feed and fodder availability could be some of the reasons for such an estimate.
Key words: Bhagnari cattle, birth weight, Droughtmaster, heritability

INTRODUCTION

A plan to develop beef breed for Pakistan started in 1969 by the introduction of five Droughtmaster cows and one bull from Australia. These animals were kept at Beef Production Research Center, Sibi, Balochistan, for crossing with local cattle breeds. Crossbreeding experiments were initiated in 1970. The plan of breed development was to cross Droughtmaster males with Bhagnari females and then cross C1 females (50% Bhagnari and 50% Droughtmaster) to the Bhagnari males to get C2 (25% Droughtmaster and 75% Bhagnari). The females from C2 were to be crossed with Droughtmaster males to get C3 (62.5% Droughtmaster and 37.5% Bhagnari). These C3 animals were crossed *inter se,* followed by the selection process for fixation of characters (Babar, 1977). The animals of 62.5% Droughtmaster and 37.5% Bhagnari inheritance were named as 'Narimaster'.

The Bhagnari cattle, apart from their good draft qualities, are considered potential beef producer. Most of the animals of this breed are found in the plains of Sibi, Karachi an Nasirabad Districts of Balochistan province where these animals are reared on crops like sorghum and millet, irrigated mainly by the flood water of Nari an Indus rivers (through Pat Feeder Canal) an the perennial water. Males of this breed weigh around 600 kg while females weigh about 480 kg (Khan et at., 1984).

Droughtmaster are crossbred cattle of Australian origin having Bos indicus inheritance between 40 to 60%. Phenotypic characteristics include broad head; large, long and well fleshed body; short and sleek coat with loose and pliable skin; and light or dark red coat colour. Animals mayor may not have horns. Males possess moderate dewlap and sheath while naval flap in females is also of moderate size. The udder in females should be well develop, moderate size, with even placement of teats. Fertility, growth rate, docility and tick resistance are some of the other important features (payne, 1970). The objective of the present study was to characterize genetic and environmental factors affecting birth weight in Droughtmaster, Bhagnari and their crossbreds at the Beef Production Research Center, Sibi.

MATERIALS AND METHODS

Birth weight records of Bhagnari, Droughmaster and their crossbreds from 1970 to 1994 obtained from Beef Research Center, Sibi were utilized. After deleting the unrealistic entries and outliers, the heritability of the trait was estimated by three different models. In the first model, data on all the different breed groups were included in the analysis. The model (Model 1) was as follows:

$$\text{Birth Weight}_{ijklm} = \text{Sire}_i\ (\text{random}) + \text{Year of Birth}_j + \text{Season of Birth}_k + \text{Sex of the Calf}_l + b_1\ (\text{Droughtmaster \%}) + \text{error}_{ijklm}$$

The sires used were required to have five or more records for the trait to be included in the analysis. Both sexes were represented in the model. Season of birth was restricted to four and was defined as Spring (February to April), Summer (May to July), Autumn (August to October) and Winter (November to January). A year by season interaction which was reported to be an important variation source for different weight traits (Bashir, 1996) was omitted from the model because the computer program used had a limitation for degree of freedom of fixed effects to be less than 99. Another model having calf's genetic group as a fixed effect, instead of percentage of Draughmaster inheritance as a covariable (Model 2), was used as under:

$$\text{Birth Weight}_{ijklm} = \text{Sire}_i\ (\text{random}) + \text{Year of Birth}_j + \text{Season of Birth}_k + \text{Sex of the Calf}_l + \text{Genetic Group of the Calf}_m + \text{error}_{ijklm}$$

The detail of the calf genetic groups is presented in Table 1. Calves with sire or dam unknown were excluded. Data on various genetic groups were also analyze separately. The model of (Model 3) analysis for birth weight in any genetic group was as follows:

Birth Weight$_{ijk}$ = Sire$_i$ (random) + Year of Birth$_j$ + Sex of the Calf$_k$ + error$_{ijk}$

Genetic parameter estimation was done by LSMLMW (Harvey, 1990).

RESULTS AND DISCUSSION

Of 1536 observations recorded for birth weight, sires were known for 1367 records (89%). The distribution of observations for different sires varied widely but for this analysis, a limit of at least 5 observations was imposed and sires with doubtful identification were deleted, leaving 1317 observations on 27 sires for analysis. Distribution of observations among sires is presented in Table 2. Maximum number of observations available for birth weight for any sire were 222 while there were four sires having 100 or more offsprings with birth weight information. The overall average for birth weight was 24.52 kg, with a standard deviation of 4.40 kg, similar to the average of overall data set (Bashir, 1996). Analysis of variance for heritability estimation by paternal half-sib correlation method using two different models are presented in Table 3. Both, Model 1 and Model 2 calculated the sire variances similarly but the genetic constitution of the calf (for which birth weight was recorded) was handled differently. It was used as a classification variable in Model 1 while in Model 2, percentage of Droughmaster inheritance was included as a covariable (Table 3), similar to the model for Simmental evaluation where percentage of Simmental blood is used as a covariable along with other important variables (British Simmental Society, 1992).

Most of the fixed effects included in these models were significant, justifying their inclusion in the model (Table 3). Birth weight was about 25-30% heritable with a range of .257 ± .079 to .318 ± .086 depending on the model. Heritability of birth weight was also estimated separately for the six major genotypes and results are presented in Tables 4 and 5. The six genotypes were Bhagnari, Droughtmaster, Cl (Droughtmaster males mated to Bhagnari females), C_2 (Cl females crossed with Bhagnari males), Cl (C_2 females crossed with Droughmaster males), and Cl x Cl (*inter se* mating between Cl animals). Model used for such analyses included sire of the calf as a random variable, and season of birth and sex of the calf as fixed effects (Model 3). Year of birth was not included due to confounding, data set being very small for each genotype. The sire effects were statistically significant for Droughmaster ($P<.05$), C_2 ($P<.01$), Cl ($P<.05$) and Cl x Cl ($P<.01$) animals. In Bhagnari and Cl' sire differences were statistically non-significant. Season of birth had a significant ($P<.01$) influence on birth weight for Cl and Cl calves. For birth weight in Bhagnari calves, this effect was important at $P<.05$. Birth weight was different for the two sexes for all genetic groups except for Cl crosses. As evident from the F-values, when sex of the calf was important, it accounted most of the variation in birth weight.

Although, standard errors were quite high, the estimates of heritability for birth weight differed among various genetic groups. Estimates for the Droughtmaster genetic group were comparatively higher as compared to other genetic groups. C_2 also had a high heritability estimate (0.59 ± 0.29) followed by Bhagnari and Cl genetic groups. The lowest heritability estimate was observed for the Cl group. Higher estimates in purebreds as compared to the crossbred populations were expected (Dunn et al., 1970, Willis et al., 1972). Lower heritability estimates in crossbred populations have been suggested due to sire by breed interaction in the study of Byrd et al. (1990). Lower estimates of heritability in Bhagnari (0.13 ± 0.16) as compared to the Droughtmaster may, however, be due to more involvement of environment in the expression of this trait as compared to genetic effect groups may be speculated along with the nutritional and managemental factors which may be responsible for each differences.

Birth weight in beef cattle has widely been studied for genetic and environmental components of variation controlling its expression. Genetic variance fluctuates across and within breeds. The most commonly reported model of estimation is paternal half-sib correlation (Mohiuddin, 1993). The need for the degrees of freedom for sires to be large, no selection among sires, absence of environmental correlation between half-sibs, and large number of offsprings per sire are some of the important requirements for such estimation (Carter an Kincaid, 1959; Mohiuddin, 1993). Other assumptions include random mating, negligible epistatic effects, and absence of genotypes by environment interaction. The proportion of additive genetic variance measured by this method may, however, include some epistatic part of the genetic variance. Multiplication of intraclass correlation by 4 (the inverse of relationship between half-sibs) may also affect the estimate. Data used in the present study were not selected in any way except for data entry errors or outliers. All the available sires were utilized except the restriction of at least 5 observations per sire. Selection of animals at the station has not been reported.

As pointed out earlier, the standard errors of heritability estimates in the present study were very high due to very limited number of observations. Fixed effects included were not all that were important due to computational difficulties. Method employed for estimation was not as good as REML. Conclusions regarding these genetic parameters are preliminary and should improve as data recording and computational facilities improve. In the absence of any information on genetic aspects of these genotypes, present results provide some guidance for future breeding plans. Conclusions: Birth weight was low but moderately heritable in Bhagnari x Droughtmaster crossbred population indicating that sire differences were appreciable for the trait. Selection for these traits by selecting for higher birth weight is likely to result in greater calving problems but may be suggested due to very low birth weights (nearly 24 kg) in these animals as compared to around 40 kg birth weight in the other beef breeds. Mating decisions for heifers would, however, need special attention in this regard. Low heritability for purebred Bhagnari calves may be associated with high environmental variation in the trait due to management and feeding. More precise recording of the trait and sire identification are suggested for more reliable estimates.

Table 1. Breed groups representedd in the data with percentage of Droughtmaster inheritance

S.No.	Blood group	Droughtmaster(%)
1	Bhagnari (BN)	0
2	Droughtmaster (DM)	100
3	BN x DM (C_1)	50
4	C_1 x BN (C_2)	25
5	C_2 x DM (C_3)	62.5
6	Sahiwal (SW)	0
7	SW x Friesian (SWFR)	0
8	Unknown	0
9	Thari	0
10	BN x Friesian	0
11	C_3 x C_3	62.5
12	Others*	0
13	BN x SW	0
14	SWFR x SW	0
15	(C_2 x BN) x SW	0

*** Crosses other than represented in this table.**

Table 2. Distribution of observations for different sires

No. of observations	No. of sires
< 10	3
10-20	7
21-40	5
41-60	6
61-100	2
>100	4
Total	27

Table3. Analysis of variance for birth weight (kg) under two statistical models

Source of variation	Model 1			Model 2		
	df	MS	F	df	MS	F
Sire (random)	26	1057.3	3.06**	26	38.0	2.89**
Year of birth	25	2926.1	8.82**	23	118.8	9.03**
Season	3	195.3	4.90**	3	53.1	4.03**
Sex of calf	1	1029.7	77.58**	1	961.0	76.07**
Calf genetic group				13	87.0	6.61**
Droughtmaster (%)	1	845.7	63.72**			
Remainder	1260	13.3 -		1224	13.2	
Heritability ± SE		0.257±.079			0.318 ± .086	

** = Significant (P<O1).

Table 4. Analysis of variance for heritability estimation of birth weight (kg) in different genetic groups

Genetic group	Parameter	Source of variation: Sire (random)	Season	Sex	Remainder
Bhagnari	df	5	3	1	178
	MS	18.58	35.59	216.40	10.83
	F	1.72NS	3.28*	19.97**	
Droughtmaster	dfl	12	3	1	55
	MS	46.37	35.33	169.13	21.49
	F	2.16*	1.64NS	7.87**	
Cl	df	11	3	1	'}fj2
	MS	19.91	68.03	65.29	13.73
	F	1.45NS	4.95*	4.75*	
C_2	df	6	3	1	378
	MS	130.22	10.35	552.97	14.85
	F	8:76**	0.69NS	37.23**	
Cl	df	6	3	1	196
	MS	33.72	66.96	35.46	15.97
	F	2.11*	4.19**	2.22NS	

1C = Bhagnari x Droughtmaster; C_2= C. x Bhagnari; Cl = C_2x Droughtmaster.
2df= Degrees offreedom; MS = Mean squares; F = F-ratio.
* = Significant (P< .05); ** = Significant (P<.01); NS = Non-significant

Table 5. Heritability estimates ± standard errors (SE) of birth weight (kg) for different genetic groups

Genetic group'	Heritability ± SE
Bhagnari	0.13 ± 0.16
Droughtmaster	0.75 ± 0.50
Cl	0.08 ± 0.11
C_2	0.59 ± 0.29
Cl	0.19 ± 0.17

·C. = Bhagnari x Droughtmaster; C_2 = Cl x Bhagnari; Cl = C_2 x Droughtmaster.

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