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HERITABILITY ESTIMATES OF SOME LINEAR TYPE TRAITS IN NILI RAVI BUFFALOES

R. H. Mirza, K. Javed*, M. Abdullah*, T. N. Pasha** and M. Akhtar

Buffalo Research Institute, Pattoki, Distt. Kasur
*Department of Livestock Production, **Department of Animal Nutrition, University of Veterinary and Animal Science Lahore, Pakistan,
Corresponding author's email: riazmirza71@yahoo.com

ABSTRACT

Most of the body conformation traits are heritable to varying levels and have been reported in almost all of the important dairy cattle breeds. Traits showing medium to high heritability estimates can be improved through selection and breeding depending upon the selection intensity and heritability of a particular trait. The present study was planned for the characterization of linear type traits in Nili Ravi buffaloes of Pakistan. One of the main objectives of the study was the genetic evaluation of Nili Ravi buffaloes for body conformation and linear type traits. A total of 1180 records on 437 Nili Ravi milking buffaloes were generated over a scoring period of two years. Pedigree records of buffaloes were traced back up to 5 available generations and these buffaloes were the progeny of 88 sires and 303 dams. Number of base animals were 119 with no pedigree records. Univariate heritability estimates of linear type traits using ASREML computer program (Gilmour, 2009) showed that most of the estimates were low to medium in range. Heritability estimates for stature, chest width, body depth, angularity, rump angle and rump width were found as 0.36±0.092, 0.10±0.081, 0.32±0.081, 0.06±0.071, 0.15±0.071, and 0.38±0.092, respectively. Heritability estimates for most of the linear type traits were found in agreement with the reports available in the literature for different dairy cattle breeds. The results might be considered for inclusion of some of the linear type traits in selection programs. However, consideration of correlation of any trait with milk yield is a prerequisite because in case of positive correlation with milk yield, improvement in both milk yield and a linear trait will be simultaneous but in case of negative correlation the case may be reverse. Among the body conformation traits, stature, body depth, rump angle and rump width are relatively more important and should be given consideration. Further studies and research with larger data set is needed to explore linear type traits and to validate the findings of the current study.

Key words: Heritability, linear type traits, Nili Ravi Buffalo, Pakistan

INTRODUCTION

Body conformation and linear type traits are very important because they are correlated with performance of dairy animals. Performance and conformation recording in most of the countries is a regular feature for all important dairy breeds where herds are evaluated routinely on the basis of these records and future breeding is planned accordingly. Most of the body and udder conformation traits are heritable to varying levels and have been reported by many workers in almost all of the important dairy cattle breeds. Traits showing medium to high heritability estimates can be improved through selection and breeding depending upon the selection intensity and heritability of a particular trait. Some of the most important and heritable traits as reported by many workers in different dairy cattle breeds included studies on stature by Viji (1990) in Tharparkar, Gengler *et al*. (1999) in Milking Shorthorn, Mrode *et al*. (2000) in Ayrshire, Wiggans *et al*. (2004) in Jersey, Dahiya (2005) in Hariana, Wiggans *et al*. (2006) in Guernsey, Haas *et al*. (2007) in Brown Swiss, Lassen and Mark (2008) in Danish Holstein, Pozveh *et al*. (2009) in Holstein, Khan (2009) in Sahiwal, Pantelic *et al*. (2010) in black and white and Zavadilova and Stipkova (2012) in Czech Holstein breed.

A lot of work on other important linear type traits including chest width, body depth, rump angle and rump width has been reported in the literature. The present study was planned for the characterization of linear type traits in Nili Ravi buffaloes of Pakistan. One of the main objectives of the study was the genetic evaluation of Nili Ravi buffaloes for body conformation and linear type traits. This included the estimation of heritabilities of various linear type traits and evaluation of possibilities to use linear type traits in future selection and breeding decisions. This might be helpful for the improvement of Nili Ravi buffalo breed in terms of physical features to bring phenotypic uniformity as well as per head productivity in coming generations.

MATERIALS AND METHODS

Nili Ravi buffalo herds maintained at 5 institutional herds in Punjab and some private breeders were utilized in this study. General management and feeding practices at these stations were almost similar during the course of study. Routine practice was to allow animals to graze on available fodders for about 4-6 hours daily depending on season. The lactating buffaloes were fed concentrate at the rate of 1 kg for every 3 kg of milk produced. Buffaloes were milked twice daily with an approximate interval of 12 hours at all the farms.

Data collection: Conformation recording was started during July, 2010 and continued till June 2012. Information including tag number of the buffalo, sire and dam number and pedigree records of sire and dam, date of birth, date of calving, lactation number and other such recorded data were collected in addition to scoring for the standard type traits.

Linear scoring of buffaloes and body measurements were recorded at day time between 7.00 AM to 3.00 PM at all the farms. On an average, 4-5 buffaloes could be scored daily. Milk yield was recorded in kilograms using weighing scale.

The guidelines for conformational recording of dairy cattle provided by the International Committee for Animal Recording (ICAR, 2007) were followed in this study. A total of 437 milking buffaloes were scored for linear type traits as follows:

1. First scoring	15 to 90 days of calving
2. Second scoring	90 to 180 days of calving
3. Third scoring	180 to 270 days of calving

Those buffaloes which became dry at the term of third scoring were still scored once for the traits under study.

Evaluation Model: Data were initially analysed using the mixed model procedure of the Statistical Analysis Systems (SAS, 2011) for the evaluation of fixed effects of age of the buffalo at scoring, stage of lactation, parity, herd and season of scoring on linear type traits. Fixed effects observed to be significant in the initial analysis were included in the model for estimation of variance components from which genetic parameters were estimated.

Genetic parameters were estimated fitting an Individual Animal Model. Heritability estimates for all linear and body conformation traits were computed using a statistical model as follows:

$Y_{ijk} = \mu + F_i + A_j + Pe + e_{ijk}$

Where,

Y_{ijk} = measurement of a particular trait:

μ = population mean;

F_i = fixed effects observed to be significant from the initial analyses

A_j = random additive genetic effect of j^{th} animal with mean zero and variance σ^2_A

$_{Pe}$ = random permanent effect of j^{th} animal with mean zero and variance σ^2_A

e_{ijk} = random error with mean zero and variance σ^2_A

Estimates of variance components and heritability for the various linear type traits were obtained by Restricted Maximum Likelihood (REML) procedure outlined by Patterson and Thompson (1971) fitting an animal model. The model accounted for fixed effects including age of the buffalo at scoring, stage of lactation, parity, herd and season of scoring. The convergence criterion (variance of function values -2 log likelihood) for variance components estimation was 1×10^{-8}. The model in matrix notation was as follow:

$y = Xb + Za + Wpe + e$

Where

y = vector of observations on linear type traits

b = vector of fixed effects (age of the buffalo at scoring, stage of lactation, parity, herd and season of scoring)

a = vector of random animal effects

pe = vector of random permanent environment effects associated to the animal

e = vector of random residual effect

X, Z, W are incidence matrices relating records to fixed, animal and permanent environment effects respectively. Note that

$Z = [0\ W]$

Where, 0 are extra columns added for the ancestors without records.

Vector **a** contains additive random animal effects while possible non-additive genetic effects are included in the **pe** vector.

It was further assumed that permanent environment effects and residual effects were independently distributed, with mean zero and variance σ^2 pe and σ^2 e respectively.

So the variances are therefore, defined as:

$var(pe) = I\sigma^2 pe$

$var(e) = I\sigma^2 e = R$

$var(a) = A\sigma^2 a$

$var(y) = ZAZ' \sigma^2 a + WI I\sigma^2 pe W' + R$

The mixed model equations (MME) for the best linear unbiased estimator (BLUE) of estimable functions of **b** and for the best linear unbiased prediction (BLUP) of **a** and **pe** pertaining to this model (Mrode, 1996) are then:

$$\begin{bmatrix} XX' & XZ' & X'W \\ Z'X & Z'Z+A^{-1}\alpha_1 & Z'W \\ W'X & W'Z & W'W+I\alpha_2 \end{bmatrix} \begin{bmatrix} b\wedge \\ a\wedge \\ P\wedge e \end{bmatrix} \Big[= \Big] \begin{bmatrix} X'y \\ Z'y \\ W'y \end{bmatrix}$$

where

$\alpha_1 = \sigma^2_e / \sigma^2_a$ and $\alpha_2 = \sigma^2_e / \sigma^2_{pe}$

The heritability was calculated by the following formula:

Heritability (h^2) = σ^2_A / σ^2_P

RESULTS AND DISCUSSION

Heritability estimates of linear type traits: A total of 1180 records on 437 Nili Ravi milking buffaloes were generated over a period of two years. Separate data and pedigree files for each trait were prepared in excel sheets and analysis was performed accordingly in ASREML computer program (Gilmour, 2009). Pedigree records of buffaloes were traced back up to 5 available generations and these buffaloes were the progeny of 88 sires and 303 dams. Out of 88 sires, male parent of 27 sires and female parent of 37 sires was also known. In other words, sires of 61 sires and dams of 51 sires were not known. Similarly, out of 303 dams, sires of 62 dams and dams of 219 dams were known in the pedigree file. Number of base animals were 119 with no pedigree records. Univariate heritability estimates of linear type traits along with standard errors in Nili Ravi buffaloes are presented in table 1. Most of the estimates observed were low to medium in range.

In case of linear traits related to body conformation, heritability estimates for stature, chest width, body depth, angularity, rump angle and rump width ranged from 0.06±0.071 for angularity to 0.36±0.092 for stature.

Stature: A high heritability estimate of stature as 0.36±0.092 has been obtained in the current study. No report for comparison on buffalo breeds is available in the literature. Even then comparison can be made with dairy cattle breeds. Most of the workers have reported heritability estimates for stature in the range of 0.30 to 0.50 including Weigel *et al*. (1997), Gengler *et al*. (1999), Royal *et al*. (2002), Dechow *et al*. (2003), Wiggans *et al*. (2004), Tsuruta *et al*. (2005), Zavadilova *et al*. (2009), Zink *et al*. (2011) and Zavadilova and Stipkova (2012) in different dairy cattle breeds. Norman *et al*. (1983) in Milking Shorthorn, Haas *et al*. (2007) in Red and White cows and Khan (2009) in Sahiwal cows have reported very high estimates of heritability for stature as 0.75, 74±0.03 and 0.81±0.020, respectively. These reports are not in agreement with the findings of the current study. A high estimate for this trait suggested that improvement in stature can be made through selection. However association of this trait with other traits and with milk yield must be considered while selecting for this trait.

Chest width: The findings of current study indicated a low heritability estimate of 0.10±0.081 for chest width. Almost similar results were reported by Dutoit *et al*. (2012) in Jersey breed as 0.08±0.01. Most of the workers have reported heritability estimate of chest width in the medium range of 0.15 to 0.30. Higher estimates were reported by Mrode *et al*. (2000) as 0.27 in Ayrshire breed, Kadarmideen and Wegmann (2003) as 0.27±0.03 in Swiss Holstein and Van dorp *et al*. (2004) as 0.26 in Holstein cows. High heritability estimate for this trait has been reported by some workers like Pryce *et al*. (2000) as 0.39±0.02 in Holstein, Viji (1990) as 0.49±0.22 in Tharparkar and Khan (2009) as 0.63±0.03 in Sahiwal cows. Little improvement in this trait through selective breeding is possible and environmental factors seem to be more important in the current study for this trait.

Table 1. Heritability estimates of linear type traits in Nili Ravi buffaloes

Trait	N	h^2 estimates
Stature	1180	0.36±0.092
Chest width	1180	0.10±0.081
Body depth	1091	0.32±0.081
Angularity	1180	0.06±0.071
Rump angle	1177	0.15±0.071
Rump width	614	0.38±0.092

Body depth: The results of present study indicated a high heritability estimate of 0.32±0.081 for body depth. Similar results were reported by Wiggans *et al*. (2004) in Guernsey cows as 0.32 and Haas *et al*. (2007) in Brown Swiss as 0.34±0.02. Most of the workers have reported heritability estimate for this trait in the medium to high range of 0.20 to 0.40 including Gengler *et al*. (1999), Mrode *et al*. (2000), DeGroot *et al*. (2002), Vukasinovic *et al*. (2002), Biscarini *et al*. (2003), Wiggans *et al*. (2004), Van dorp *et al*. (2004), Wall *et al*. (2005), Wiggans *et al*. (2006), Lassen and Mark (2008), Daliri *et al*. (2008), Pozveh *et al*. (2009), Zavadilova *et al*. (2009) and Zavadilova and Stipkova (2012). In contrast to these findings, very high estimates were reported by Haas *et al*. (2007) in Red & White cows as 0.59±0.03 and maximum value for this trait was reported by Khan (2009) as 0.67±0.03 in Sahiwal cows. This trait can be improved through selective breeding in Nili Ravi buffaloes.

Angularity: In the present study, heritability estimate for angularity was found as 0.06±0.071. Slightly higher estimate was reported by Kawahara *et al*. (1994) in Holstein cows as 0.14, Pozveh *et al*. (2009) as 0.23±0.03 in Holstein and Zavadilova and Stipkova (2012) as 0.22

in Czech Holstein cows. Most of the reports indicated heritability estimate for this trait in the range of 0.15 to 0.35. Some of the reports indicated a very high heritability estimate of angularity as 0.80 by Mrode and Swanson (1994), as 0.51 by Mrode *et al*. (2000) and as 0.54±0.04 by Khan (2009). These reports do not match with the findings of current study. Low heritability estimate for angularity might be due to differences among species, breed, data size and method of estimation or differences in use of models.

Rump angle: Heritability estimate for rump angle was found as 0.15±0.071 in the current study. Almost similar results were reported by Norman *et al*. (1983) as 0.13 in Ayrshire cows and Thompson *et al*. (1983) as 0.17±0.03 in Holstein cows. Most of the reports indicated a medium to high range of 0.25 to 0.35 for heritability estimate of this trait. High heritability estimates for this trait were documented by Wiggans *et al*. (2004) as 0.41 and Daliri *et al*. (2008) as 0.41±0.01 in Guernsey and Holstein breed, respectively. The findings of current study are low and this may be due to relatively smaller data set and incomplete pedigree records.

Rump width: An estimate of 0.38±0.092 for heritability of rump width was observed in the current study. Nearly same results were reported by Dahiya (2005a) as 0.35±0.28 in Sahiwal breed. Most of the workers have reported heritability estimate for this trait in range of low to medium value of 0.10 to 0.25 including Gengler *et al*. (1999), Uribe *et al*. (2000), Boelling *et al*. (2001), Royal *et al*. (2002), Wiggans *et al*. (2004), Tsuruta *et al*. (2005), Boelling *et al*. (2007), Daliri *et al*. (2008), Laursen *et al*. (2009), Linde *et al*. (2010), Ptak *et al*. (2011) and Zavadilova and Stipkova (2012). A very high heritability estimate was reported by Khan (2009) as 0.72±0.02 and Dahiya (2005) as 0.54±0.23 in Sahiwal and Hariana cows, respectively. High heritability estimate indicates a chance of improvement in this trait through selection and breeding.

Conclusions: Heritability estimates for most of the linear type traits were found as low to medium in range in the current study. The reasons of relatively low estimates might be due to species differences and relatively small data set as well as incomplete pedigree records. Even then the results might be considered for inclusion of some of the linear type traits in selection programs. However, consideration of correlation of any trait with milk yield is a prerequisite because in case of positive correlation with milk yield, improvement in both milk yield and a linear trait will be simultaneously but in case of negative correlation the case may be reverse. Among the body conformation traits, stature, body depth, rump angle and rump width are relatively more important and should be given consideration.

Keeping in view that this is a preliminary study on genetic aspects of linear type traits in Nili Ravi buffaloes, further studies and research with larger data set is needed to explore linear type traits and to validate the findings of the current study.

REFERENCES

Biscarini, F., S. Biffani and F. Canavesi (2003). Genetic analysis of type traits for the Italian Jersey breed. Interbull bull. 31:80-83.

Boelling, D., P. Madsen and J. Jensen (2001). Genetic parameters of foot and leg traits in future AI bulls. Acta. Agric. Scand. Sect. A. Anim Sci. 51(2):122-128.

Boelling, D., A. Fogh and U. S. Nielsen (2007). Locomotion as a new trait; first results from Denmark. Interbull Bull. 37: 175-178.

Dahiya, S. P. (2005). Linear functional type traits for reproductive efficiency in Hariana cows. Ind. J. Anim. Sci. 75(5): 524-527.

Dahiya, S. P. (2005a). Appraisal of linear type traits for reproductive efficiency in Sahiwal cows. Ind. J. Anim. Sci. 75(8): 945-948.

Daliri, Z. S., H. Hafezian, A. Shad Parvar and G. Rahimi (2008). Genetic relationship among longevity, milk production and linear type traits in Iranian Holstein cattle. J. Anim. and Vet. Adv. 7 (4): 512-515.

Dechow, C. D., G. W. Rogers, L. Klei and T. J. Lawlor (2003). Heritabilities and correlations among body condition score, dairy form and selected linear type traits. J. Dairy Sci. 86(6): 2236-2242.

DeGroot, B. J., J. F. Keown, L. D. Van-Vleck and E. L. Marotz (2002). Genetic parameters and responses of linear type, yield traits, and somatic cell scores to divergent selection for predicted transmitting ability for type in Holsteins. J. Dairy Sci. 85(6): 1578-1585.

Dutoit, J., J. B Van Wyk and A. Maiwashe (2012). Relationships between functional herd life and conformation traits in the South African Jersey breed. S. Afr. J. Anim. Sci. 42 (1) 47-54.

Gengler, N., G. R. Wiggans and J. R. Wright (1999). Animal model genetic evaluation of type traits for five dairy cattle breeds. J. Dairy Sci. 82 (6):1350e1-1350e22.

Gilmour, A. R., B. J. Gujel, B. R. Cullis and R. Thompson (2009). ASReml User Guide (Version 3.0), VSN International Ltd, Hemel Hempstead, HP1 1ES, UK.

Haas, Y. De., L. L. G. Janss and H. N. Kadarmideen (2007). Genetic and phenotypic parameters for conformation and yield traits in three Swiss dairy cattle breeds. J. Anim. Breed. & Genet. 124 (1): 12-19.

ICAR (2007). International Agreement of Recording Practices, Approved on 9 June, 2006.

Kadarmideen, H. N. and S. Wegmann (2003). Genetic parameters for body condition score and its relationship with type and production traits in Swiss Holsteins. J. Dairy Sci. 86(11):3685-3693.

Kawahara, T., T. Masaya, M. Nakata, M. Suzuki and T. Mitsumoto (1994). Estimation of genetic parameters of a Holstein population associated with linear type traits. Anim. Sci. and Tech. 65(11): 1051-1056.

Khan, M. A. (2009). Characterization of Sahiwal cattle for linear type traits. Ph.D. thesis, University of Agriculture, Faisalabad, Pakistan.

Lassen, J. and T. Mark (2008). Short communication: Genotype by housing interaction for conformation and workability traits in Danish Holsteins. J. Dairy Sci. 91(11):4424-4428.

Laursen, M. V., D. Boelling and T. Mark (2009). Genetic parameters for claw and leg health, foot and leg conformation and locomotion in Danish Holsteins. J. Dairy Sci. 92 (4):1770-1777.

Linde, C. V. D., G. delong, E. P. C. Koenen and H. Eding (2010). Claw health index for Dutch dairy cattle based on claw trimming and conformation data. J. Dairy Sci. 93(10):4883–4893.

Mrode, R. A., G. J. T. Swanson and C. M. Lindberg (2000). Genetic correlations of somatic cell count, and conformation traits with herd life in dairy breeds, with an application to national genetic evaluations for herd life in United Kingdom. Livest. Prod. Sci. 65(1-2): 119-130.

Mrode, R. A. and G. J. T. Swanson (1994). Genetic and phenotypic relationships between conformation and production traits in Ayrshire heifers. Anim, Prod. 58(3): 335-338.

Mrode, R. A. (1996). Linear models for the prediction of animal breeding values. CAB International, UK.

Norman, H. D, R. L. Powell, W. A. Mohammad, J. R. Wright (1983). Effect of herd and sire on uniform functional type trait appraisal scores for Ayrshire, Guernseys, Jerseys, and Milking Shorthorns. J. Dairy Sci. 66(10): 2173-2184.

Pantelic, V., L. Samolovac, S. Aleksic, S. Trivunovic, M. Malin, Petrovic, D. Ostojic-Andric and Z. Novakovic (2010). Heritability of type traits in first calving black and white cows. Archiv. Tierzucht 53 (5):545-554.

Patterson, H. D. and R. Thompson (1971). Recovery of inter-block information when block size are unequal. Biometrika. 58(3): 545-554.

Pozveh, S. T., A. A. Shadparvar, M. M. Shahrbabak and M. D. Taromsari (2009). Genetic analysis of reproduction traits and their relationship with conformation traits in Holstein cows. Livest. Sci. 125(1): 84-87.

Pryce, J. E., M. P. Coffey, and S. Brotherstone (2000). The genetic relationship between calving interval, body condition score and linear type and management traits in registered Holsteins. J. Dairy Sci. 83(11):2664–2671.

Ptak, E., W. Jagusiak, A. Zarnecki and M. Otwinowska (2011). Heritabilities and genetic correlations of lactational and daily somatic cell score with conformation traits in Polish Holstein cattle. Czech J. Anim. Sci. 56: (5) 205-212.

Royal, D., J. E. Pryce, J. A. Woolliams and A. P. F. Flint (2002). The genetic relationship between commencement of luteal activity and calving interval, body condition score, production, and linear type traits in Holstein Friesian dairy cattle J. Dairy Sci. 85(11):3071–3080.

SAS Institute (2011). SAS/STAT user's guide, Release 9.3. Carry, North Carolina, USA.

Thompson, J. R., K. L. Lee, A. E. Freeman and L. P. Johnson (1983). Evaluation of a linearized type appraisal system for Holstein cattle. J. Dairy Sci. 66 (2):325-331.

Tsuruta, S., I. Misztal and T. J. Lawlor (2005). Changing definition of productive life in US Holsteins: effect on genetic correlations. J. Dairy Sci. 88(3):1156-1165.

Uribe, H., L. R. Schaeffer, J. Jamrozik and T. J. Lawlor (2000). Genetic evaluation of dairy cattle for conformation traits using random regression models. J. Anim. Breed. Genet. 117(4):247-259.

Van Dorp, T. E., P. Bortcher and L. R. Schaeffer (2004). Genetics of locomotion, Lives. Prod. Sci. 90 (2-3) :247-253.

Viji, P. K., D. S. Balain, M. George and A. K. Vinayak (1990). Linear type traits and their influence on milk production in Tharparkar cattle. Ind. J. Anim. Sci. 60(7): 845-852.

Vukasinovic, N., Y. Schleppi and N. Kunzi (2002). Using conformation traits to improve reliability of genetic evaluation for herd life based on survival analysis. J. Dairy Sci. 85 (6):1556-1562.

Wall, E., I. M. S. White, M. P. Coffey and S. Brotherstone (2005). The relationship between fertility, rump angle, and selected type information in Holstein-Friesian cows. J. Dairy Sci. 88(4):1521-1528.

Weigel, D. J., B. G. Cassell and R. E. Pearson (1997). Prediction of transmitting abilities for productive life and lifetime profitability from production, somatic cell count, and type traits in milk markets for fluid milk and cheese. J. Dairy Sci. 80(7):1398–1405.

Wiggans, G. R., N. Gengler and J. R. Wright (2004). Type trait co-variance components for five dairy breeds. J. Dairy Sci. 87(7):2324-2330.

Wiggans, G. R., L. L. M. Thornton, R. R. Neitzel and N. Gengler (2006). Genetic parameters and evaluation of rear legs (rear view) for Brown Swiss and Guernseys. J. Dairy Sci. 89(12): 4895-4900.

Zavadilova, L., E. Nemcova, M. Stipkova and J. Bouska (2009). Relationship between longevity and conformation traits in Czech Fleckvieh cows. Czech J. Anim. Sci. 54(9): 385-394.

Zavadilova, L. and M. Stipkova (2012). Genetic relationship between longevity and conformation traits in the Czech Holstein population. Czech J. Anim. Sci. 57(3): 125-136.

Zink, V. A., M. A. Atapkova and J. A. Lassen (2011). Genetic parameters for female fertility, locomotion, body condition score and linear type traits in Czech Holstein cattle. J. Dairy Sci. 94(10):5176-5182.