

GENETIC AND NON GENETIC FACTORS AFFECTING SOME UDDER MEASUREMENTS IN NILI RAVI BUFFALOES OF PAKISTAN

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ABSTRACT

Udder length, width and height are very important parameters to identify good dairy animals. Udder measurements including length, width and height on 437 Nili Ravi buffaloes were recorded before and after milking with 1180 records at 6 Experimental Stations in Punjab, Pakistan. Heritabilities were estimated using Best Linear Unbiased Prediction techniques. Environmental factors *viz* age of the buffalo at scoring, stage of lactation, parity, herd and season were included in the model. Least square means for udder length, width and height before milking were found as 52.65±6.87, 53.52±6.19 and 54.34±4.99 cm and after milking as 47.08±6.57, 48.15±5.79 and 55.39±5.15 cm, respectively. Heritability estimates for udder length, width and height before milking were found as 0.08±0.07, 0.22±0.08 and 0.22±0.09, while after milking as 0.14±0.07, 0.20±0.08 and 0.09±0.08, respectively. All the factors significantly affected before milking udder length. A significant effect of herd, parity, season of scoring and age on

udder width before milking was observed. Herd, stage of lactation, parity and age of the buffalo at scoring significantly affected udder height before milking. Significant effect of herd, parity, stage of lactation and age of the buffaloes at classification on most of the traits suggest that managerial factors are important. Moderate heritability estimates for these udder traits provide a fair scope for improvement through selection and breeding which will help to increase milk yield in Nili Ravi buffaloes.

Keywords: buffalo, *Bubalus bubalis*, heritability, udder measurements, Pakistan, Nili Ravi buffalo, non genetic factors

INTRODUCTION

Good udder conformation is very important for high milk production in dairy animals. Udder length, width and height are some of the most important parameters to identify animals with

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good udders.

Many research workers have reported that udder size and shape are important conformation characteristics for economical and efficient milk production. Udder length, width and height can be a good predictor of lactation performance. Bhuiyan *et al.* (2004) reported that the size and shape of udder are very important conformation traits which can play a vital role for the suitable selection of animals for economic milk production and they should be considered for selecting dairy cows. Deng *et al.* (2012) reported that udder length was the most important parameter related to milk yield in Kenana X Friesian cows and can be used for prediction of milk yield.

Udder conformation traits are also very important because they have been reported to be heritable. Petersen *et al.* (1986); Seykora *et al.* (1985) have reported heritability estimates for udder height as 0.77 ± 0.26 and 0.51 , respectively. Khan (2009) has reported heritability estimate for udder length, average udder width and udder height as 0.65 ± 0.03 , 0.63 ± 0.03 and 0.77 ± 0.02 , respectively.

Studies on udder conformation traits indicate that they are affected by various factors like herd, parity, stage of lactation and age of the cow or buffalo at scoring. Kuczaj (2003) has reported significant effect of parity on udder height. Khan (2009) has reported a highly significant effect of herd, parity, stage of lactation and age on before milking udder height. Prasad *et al.* (2010) reported a significant effect of parity on udder length and udder width in Murrah buffaloes. Deng *et al.* (2012) has reported highly significant effect of parity but no effect of stage of lactation on udder length in Kenana X Friesian cows.

Keeping in view the importance of udder conformation traits in dairy cattle, the present

study was planned. One of the main objectives of the study was to evaluate udder conformation traits in Nili Ravi buffaloes and to estimate genetic parameters of these traits for possible use in future selection program.

MATERIALS AND METHODS

Five herds of Nili Ravi breed of buffalo and some private breeders were utilized in this study. General management and feeding practices at these stations were almost similar and have been more or less the same since the introduction of Nili Ravi buffaloes.

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, age and weight at first calving, live weight, calf sex, calf number, calf birth weight and other such recorded data were collected in addition to scoring for udder conformation traits.

Udder measurements were recorded before and after milking. Before milking measurements were recorded within half an hour before the start of milking time early in the morning and in the evening as per methodology, however after milking measurements were recorded immediately.

A total of 437 milking buffaloes were scored for udder conformation traits. First scoring was done within 15 to 90 days of calving and then each measurement was recorded after about 90 days of first scoring. Udder measurements such as udder length, width, and height before and after milking were recorded. Methods of measurement

of udder conformation traits are presented in Table 1.

Statistical model

Heritabilities were estimated using BLUP (Best Linear Unbiased Prediction) evaluation techniques. Influencing factors such as age of the buffalo at scoring, stage of lactation, parity, herd and season were included in the model. Individual Animal Model was fitted under Restricted Maximum Likelihood (REML) Procedure outlined by Patterson and Thompson (1971). Season of scoring was defined as 1 (hot and humid summer) from July to September, 2 (autumn) from October and November, 3 (winter) from December to January, 4 (spring) from February to April, and 5 (hot dry summer) from May and June.

The following fixed effects were included in the model

Herd: 1 to 6; Season of linear type classification: 1 to 5

Parity: 1 to 4 (1st, 2nd, 3rd, 4th and latter); Stage of lactation: 1 to 4 (Early, mid, late and dry)

Age of the buffalo at scoring date; The following general mathematical model was used

$$Y_{ijklm} = \mu + S_i + H_j + P_k + T_l + b_1(a_{ijklm}) + b_2(a_{ijklm})^2 + e_{ijklm} \quad (\text{Model 1})$$

Where; Y_{ijklm} = the record of mth buffalo at lth stage of lactation during kth parity of jth herd in ith season

μ = the overall population mean

S_i = the effect due to ith season

H_j = the effect due to jth herd

P_k = the effect due to kth parity

T_l = the effect due to lth stage of lactation

a_{ijklm} = the age of buffalo at classification

b_1 and b_2 = the linear and quadratic regression coefficient of age at classification

e_{ijklm} = the random error associated

with the record on mth buffalo at lth stage of lactation during kth parity of jth herd in ith season

Data were analysed using the mixed model procedure of the Statistical Analysis Systems (SAS, 2011). 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.

Estimation of genetic parameters

Genetic parameters were estimated fitting an Individual Animal Model. The ASREML set of computer programs was used to estimate genetic parameters.

Heritability estimates for udder conformation traits were computed using a statistical model as follows:

$$Y_{ijk} = \mu + F_i + A_j + Pe + e_{ijk} \quad (\text{Model 2})$$

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 jth animal with mean zero and variance σ^2_A

Pe = random permanent effect of jth animal with mean zero and variance σ^2_A

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

The heritability was calculated by the following formula:

$$\text{Heritability } (h^2) = \sigma^2_A / \sigma^2_P$$

Where; h^2_i = heritability of ith trait

σ^2_{Ai} = additive genetic variance for the ith

trait

σ_{pi}^2 = phenotypic variance for i^{th} trait

σ_{Ei}^2 = residual variance for the i^{th} trait

All these analyses were performed by the Restricted Maximum Likelihood method (REML) using the software ASREML (Gilmour, 2009).

RESULTS AND DISCUSSION

A total of 1180 records on different udder measurements were generated over a scoring period of 2 years. Data structure and distribution of records for udder measurements in Nili Ravi Buffaloes have been presented in Table 2.

Environmental factors expected to cause variation like herd, stage of lactation, parity, season of scoring and age of the buffalo at classification were included in the model along with genetic and residual effects on udder measurements. Heritabilities of different udder measurements were estimated using Model 2.

Description of udder conformation traits

Least squares means for udder length, width and height were found as 52.65±6.87, 53.52±6.19 and 54.34±4.99 cm, Least squares means for udder measurements in Nili Ravi buffaloes have been given in Table 3. Khan (2009) has reported before milking udder length as 44.8±7.43 cm in Sahiwal cows. Chachare and Walkunde (2011) reported that pre milking udder length was 33.798 cm. These findings are lower and do not coincide with the findings of current study. Prasad *et al.* (2010) has reported udder length as 54.16±0.34 cm and udder width as 50.63±0.36 cm in Murrah buffaloes these findings nearly coincide with the findings of current study. Chandrasekar *et*

al. (2016) has reported udder length as 50.42±1.08 cm in Nili Ravi buffaloes which nearly coincide with the findings of current study.

Khan (2009) has reported average udder width as 59.1±9.06 cm in Sahiwal cows, Chachare and Walkunde (2011) reported that pre milking udder width was 23.556 cm. Chandrasekar *et al.* (2016) has reported udder width as 46.92±1.01 cm in Nili Ravi buffaloes these results do not coincide with the findings of current study.

Abdullah *et al.* (2013) has reported udder length as 64.2±7.3 cm which is higher than the findings of current study and udder width as 29.1±4.1 cm in Nili Ravi buffaloes which is lower than the findings of current study. Khan (2009) has reported udder height as 59.9±5.22 cm in Sahiwal cows and Jaayid *et al.* (2011) has reported this measurement as 70.33±4.59 cm in Iraqi buffaloes. These values are higher and do not coincide with the findings of current study. Patel *et al.* (2016) reported udder length as 58.24±0.68 cm and udder width as 65.45±0.70 cm in crossbred cows, these findings are higher and do not coincide with the findings of current study.

Praveen Bharti *et al.* (2015) has reported 34.75±0.54 cm udder length, 22.66±0.3 cm udder width and 54.15±0.38 cm udder height in Murrah buffaloes. Modh *et al.* (2017) reported that average udder length was 61.95±1.20 cm and width was 62.99±1.17 cm in Gir cows.

A large variation among results on udder measurements reported by different researchers might be due to difference in breeds, trait definition, herd, year, parity, age and stage of lactation.

After milking udder measurements in the current study were observed for udder length as 47.08±6.57 cm, average udder width as 48.15±5.79 and udder height as 55.39±5.15 cm, A decrease in size of about 10.6% in udder length and 10.01%

in udder width before and after milking has been observed. No considerable change in udder height was found before and after milking. Deng *et al.* (2012) has reported after milking udder length as 36.6 ± 6.24 cm in Kenana X Friesian cows. Chachare and Walkunde (2011) reported that post milking udder length was 29.425 cm and Khan (2009) has reported this value as 42.2 ± 5.95 cm. These values are lower than the findings of the current study. Prasad *et al.* (2010) has reported udder width of 50.63 ± 0.36 cm in Murrah buffaloes. This value is comparable to some extent. Singh *et al.* (2010) reported udder width as 55.25 ± 0.87 cm in Vrindavani cows and Khan (2009) reported this value as 52.9 ± 8.06 cm in Sahiwal cows. Chachare and Walkunde (2011) reported that post milking udder width was 20.41 cm. These findings do not agree with the findings of current study. Khan (2009) has reported after milking udder height as 62.0 ± 5.09 which is about 7 cm higher than the findings of the current study.

Environmental factors affecting udder conformation traits

All of the udder conformation traits before and after milking were highly significantly different in different herds ($P < 0.001$). Stage of lactation was found to be highly significant source of variation ($P < 0.001$) for before milking udder length, before milking udder height and after milking udder length, however before milking average udder width, after milking average udder width and after milking udder height were not affected by this factor.

All of the above mentioned traits were significantly affected by parity. Season of scoring significantly affected before milking udder length ($P < 0.01$), before milking average udder width ($P < 0.05$) and after milking average udder width

($P < 0.01$), Rest of all the traits were not significantly different in different seasons.

Most of the udder traits were significantly affected by linear and quadratic effect of age of the buffalo at classification. Prasad *et al.* (2010) has reported a significant effect of parity on udder length and udder width ($P < 0.05$). Modh *et al.* (2017) reported that parity was a significant source of variation for udder length and udder widths ($P < 0.05$)

Khan (2009) has reported significant effect of herd, parity, stage of lactation and age on udder length. Deng *et al.* (2012) has reported significant effect of parity on before milking udder length in Kenana x Friesian cows. These reports coincide with the findings of current study. However, Deng *et al.* (2012) has reported non significant effect of stage of lactation on udder length.

The findings of current study indicated a significant effect of herd, parity, season of scoring and age on average udder width before milking. Prasad *et al.* (2010) has reported significant effect of parity on udder width in Murrah buffaloes. Khan (2009) has reported significant effect of herd, parity, stage of lactation and age on this trait. These reports are in line with the findings of current study.

Herd, stage of lactation, parity and age of the buffalo at scoring were found as significant sources of variation for udder height before milking in the current study. Tilki *et al.* (2005) has reported significant effect of parity on this measurement ($P < 0.05$). Khan (2009) has reported significant effect of herd, parity, stage of lactation and age on udder height. These reports are in accordance with the findings of current study. Udder length after milking was affected by the same factors as udder length before milking except the effect of season which was not significant on udder length after

milking. After milking average udder width was affected by the same factors as before milking udder width. After milking udder height was affected by the same factors except the effect of stage of lactation which was found as non significant. Khan (2009) has reported significant effect of herd, stage of lactation, parity and age on after milking udder length, udder width and udder height. Tilki *et al.* (2005) has reported significant effect of parity on after milking udder height. Highly significant difference among udder measurements at different herds might be due to managemental differences. Variation in feed and fodder supply at different farms and the quality of feed and fodder during the course of study might be the reason of differences in size of udder dimensions (Table 4 and 5).

Change in size of udder in terms of length and width with increase in lactation number (parity) might be the result of growth and development of secretary tissues.

Heritability estimates of udder conformation traits

Separate data and pedigree files for each trait were prepared in excel sheets and analysis was performed accordingly in ASREML computer program (Gilmour, 2009). Buffalo pedigree records were traced back up to 5 available generations and these buffaloes were the progeny of 88 sires and 303 dams. Number of base animals was 119 with no pedigree records.

Udder conformation traits

Udder measurements were recorded before and after milking and their heritability estimates were calculated under univariate animal model procedure using ASREML computer software (Gilmour, 2009). Heritability estimates for before milking udder length, average udder width and

udder height were found as 0.08 ± 0.07 , 0.22 ± 0.08 and 0.22 ± 0.09 , respectively. The corresponding values after milking for these traits were observed as 0.14 ± 0.07 , 0.20 ± 0.08 and 0.09 ± 0.08 , respectively. Khan (2009) has reported very higher heritability estimates for these traits as 0.65 ± 0.03 , 0.63 ± 0.03 and 0.77 ± 0.02 , respectively in Sahiwal cows. Jaayid *et al.* (2011) has also reported a very higher heritability estimates for udder height as 0.72

Khan and Khan (2016) has reported very higher heritability estimates for udder length as 0.68 ± 0.03 and udder width as 0.66 ± 0.03 in Sahiwal cows. Similarly very high heritability estimate for udder length (0.76 ± 0.33) and for udder width (0.63 ± 0.32) were reported for Gir cows by Qureshi *et al.* (1980).

Most of the reports available in the literature indicated high heritability estimates for udder traits. Low to medium heritability estimates for most of the udder traits in current study indicated that improvement in udder traits through selection in Nili Ravi buffaloes might be effective to some extent but environmental factors should also be given attention for improvement.

CONCLUSIONS

Least squares means for most of the udder measurements are generally in agreement with the reports in literature. Most of the udder traits were significantly affected by herd, parity, stage of lactation and age of the buffaloes at classification which indicated that improvement can be by modifying these factors. Most of the udder measurements have been found lowly to moderately heritable and this provides a fair scope for improvement of these traits through selection and breeding.

Table 1. Description of methods of measurement of udder conformation traits.

Trait	Method
Udder length	Distance between fore udder attachment and rear udder height passing a measuring tape through left and right halves of udder
Udder width	It was taken as average of two distances: a) distance between two lateral lines at the base of udder near stifle joint passing a cloth tape in between fore and hind teats and b) distance between two lateral lines at the base of udder near stifle joint passing a cloth tape just at front of fore teats
Udder height	Vertical distance between ground floor to the udder floor at lowest point

Table 2. Data structure and distribution of records for linear type traits in Nili Ravi buffaloes.

Effect	Levels	Components of effect	Number of records
Herd	1	Bhunikey	227
	2	Chack Katora	297
	3	Haroonabad	172
	4	Khushab	165
	5	Rakh Ghulaman	269
	6	Private	50
Stage of lactation	1	Up to 90 days	334
	2	91-180 days	391
	3	181 and above	334
	4	Dry	121
Parity	1	First parity	233
	2	Second parity	175
	3	Third parity	212
	4	Forth and later parities	560
Season of scoring	1	July to September (humid hot)	150
	2	October and November (Autumn)	258
	3	December and January (Winter)	266
	4	February to April (spring)	312
	5	May and June (hot dry)	194

Table 3. Least squares means for udder measurements in Nili Ravi buffaloes.

Variable	N	Mean±Std Dev	Coefficient of variation (%)	Range
Before milking udder length (cm)	1055	52.65±6.87	13.049	33-82
Before milking average udder width (cm)	1055	53.52±6.19	11.566	35-83
Before milking udder height (cm)	1172	54.35±4.99	9.183	39-69
After milking udder length (cm)	1052	47.08±6.57	13.956	28-71
After milking average udder width (cm)	1052	48.15±5.79	12.028	29.5-67.5
After milking udder height (cm)	1052	55.39±5.15	9.306	30-69

Table 4. Level of significance and F-value for udder conformation traits in Nili Ravi buffaloes.

Trait	Herd	Stage	Parity	Season
Before milking udder length (cm)	30.47***	31.13***	9.34***	3.82**
Before milking average udder width (cm)	15.16***	2.76 ^{NS}	4.20*	5.78**
Before milking udder height (cm)	51.34***	13.29***	3.62*	0.81 ^{NS}
After milking udder length (cm)	34.95***	23.81***	15.06***	2.36 ^{NS}
After milking average udder width (cm)	11.92***	0.41 ^{NS}	5.79**	5.41**
After milking udder height (cm)	47.41***	2.76 ^{NS}	6.19**	0.28 ^{NS}

* = P<0.05; ** = P<0.01; *** = P<0.001; NS = Non significant

Table 5. Regression coefficients for udder measurements for age of cow at classification in Nili Ravi buffaloes.

Traits	$\hat{\alpha}$	b_1	b_2
Before milking udder length (cm)	33.128	0.278***	-0.0008***
Before milking average udder width (cm)	44.159	0.124***	-0.0003*
Before milking udder height (cm)	63.814	-0.13***	0.0004***
After milking udder length (cm)	26.594	0.289***	0.0009***
After milking average udder width (cm)	35.799	0.170***	-0.0005***
After milking udder height (cm)	65.465	-0.0137***	0.0004***

* = P<0.05; ** = P<0.01; *** = P<0.001; NS = Non significant

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