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Estimation of Genetic Parameters for Productive Traits of Murrah Buffaloes in Kaski, Nepal

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Abstract

A research was carried out at Livestock Development Farm, Kaski, Nepal during January 2014 to June 2014 with the objective of evaluating and estimating genetic parameters of Murrah buffaloes. The lactation records of 332 Murrah buffaloes calved during period from 2002 A.D.to 2012 A.D. were utilized for the study. The production traits considered for estimation of genetic parameters were lactation length (LL), daily milk yield (DMY), annual milk yield (AMY) and lactation yield (LYD) whereas the non-genetic factors considered were year of calving, season of calving and dam's parity. The data on production traits were analyzed for heritability, phenotypic and genetic correlation coefficient by the method of paternal half sib correlation using the least -squares and maximum likelihood computer program of Harvey (1990). The least square means of lactation length, daily milk yield, annual milk yield and lactation yield were 362.77±4.49 days, 4.53±0.06 kg, 1540.34±17.86 kg and 1838.45±32.33kg respectively. Among the non-genetic factors, dam's parity had significant effect on all production traits considered (P<0.001). Daily milk yield and annual milk yield differed with respect to year of calving (P<0.05) whereas Season of calving had significant effect on lactation length (P<0.05), daily milk yield and annual milk yield (P<0.01). Heritability estimates for LL, DMY, AMY and LYD were found to be 0.11±0.11, 0.18±0.14, 0.23±0.15 and 0.19±0.14 respectively. The genetic correlations between the productive traits were all positive ranging from 0.23±0.15 between LL and DMY and 0.84±0.17 between LYD and DMY. The phenotypic correlation ranged from 0.14 between LL and AMY and 0.95 between AMY and DMY. In general, correlations were large and positive indicating that selecting one trait will positively affect the other trait. However, more records on productive traits of half sibs should be included in the analysis in order to minimize standard errors and increase the reliability of the genetic parameters estimated.

Key words: murrah; heritability; genetic correlation; non-genetic factors; parity

1. INTRODUCTION

Agriculture sector in Nepal contributes about 35.33% to National GDP and provides employment opportunities to 66% of the economically active population (MOAD, 2014). Livestock sub-sector is an important output of agriculture that contributes about 25.68% to Agriculture GDP. Within Livestock sub-sector, cattle and buffaloes contribute about 28% (MOAD, 2014). Buffaloes are the major livestock commodity in Nepal. Nepal, in terms of buffaloes head, ranks fourth in Asia only after India, Pakistan and China (Pasha & Hayat, 2012). The importance of buffaloes in national economy can be manifested as buffaloes contribute about 66.84% of total milk and 58% of the total meat produced in the country and ranks at first among all species (Economic Survey, 2014). There has been an increase in the number of buffaloes over the last few years. The population of milking buffaloes in Nepal has increased from 9.8 million (2002 A.D.) to 13.3 million (2012 A.D.) with an annual average growth rate of 3.45% per annum (Economic Survey, 2014). Among the total buffalo population in the country, 35% of the buffaloes in Nepal are Murrah and their crosses and rest of others are indigenous breeds (Lime, Parkote, Gaddi).

Murrah buffaloes (water buffaloes) represent an important national genetic resource of the country. Cross breeding of the indigenous breeds of buffaloes with Murrah has been the national policy of the genetic improvement program (NARC, 2014). Therefore, it becomes imperative to genetically evaluate the production traits of Murrah buffaloes as a way of increasing their productivity through selection. Estimate of heritability is an important population parameter which measures the degree of correspondence between phenotypic value and breeding value of a trait of interest. This estimate of heritability is important in predicting the genetic improvement of a trait expected as a result of selection. Similarly, genetic correlation estimates the degree of association between genes responsible for genetic part of the variance whereas phenotypic correlation is an expression of the observed relationship between phenotypic performances of traits of interest. This knowledge of genetic and phenotypic correlation is valuable in determining the method of selection and breeding system adopted for improvement of economic traits and for the estimation of genetic response (Sarubbi et al., 2012). Thus, heritability and estimation of genetic and phenotypic correlations are important population parameters required for planning appropriate selection and breeding strategies for the genetic improvement of dairy animals. However, there are very few studies reporting genetic parameters estimates of Murrah buffaloes in Nepal.

The objective of the present study was to investigate the potential for genetic improvement of Murrah buffaloes by estimating genetic parameters associated with the production traits. It is envisaged that the information so generated could be used to improve the farm management and increase potential productivity of the Murrah herd.

2. MATERIALS AND METHODS

2.1 Sources of data:

This study was carried out between January 2014 to June 2014 at Livestock Development Farm, Kaski, Nepal. The lactation records of 332 Murrah buffaloes that calved over 10 years' period (2002-2012 A.D.) were included in the study. The effect of environmental factors viz. year of calving, season of calving and dam's parity affecting production traits were studied. The production traits consider for estimates of heritability, phenotypic and genetic correlations are as follows:

Table 1: Production traits for estimation of heritability, genetic and phenotypic correlations

Traits	Descriptions
Lactation Length **(LL)**	Total days in one lactation period
Daily Milk Yield **(DMY)**	Average daily milk yield in one lactation period
Annual Milk Yield **(AMY)**	Total milk yield in 305 days
Lactation Yield **(LYD)**	Total milk yield in one lactation period

2.2 Data structure:

The lactation records of 332 Murrah buffaloes, progeny of 48 sires, calved during period from 2002 to 2012 A.D. maintained at Government Livestock farm, Kaski, Nepal were obtained for data analysis. Sires with at least 3 progenies were considered for the study. Culling in the middle of lactation, abortion, still birth or any other pathological causes affecting milk yield were considered abnormalities and such records were not used in the present investigation. The duration of 10 years was divided into 5 periods of 2 years each. On the basis of availability of fodder and geo climatic conditions, the year was divided into 3 seasons delineated as summer (February to May), rainy (June to September) and winter (October to January). All of the seasons prevail in the farm year round. First and Second lactation were considered as Early parity, third and fourth lactation were considered as Mid parity and Five and above were considered as Advanced parity

Table 2: Descriptive statistics of productive traits used in the analyses

Traits	Number of records	Mean±S.E.	Range		CV %
			Minimum	Maximum	
Lactation Length **(LL)**	332	363.77±5.49	339.76	374.83	18.65
Daily Milk Yield **(DMY)**	332	4.55±0.09	4.23	4.79	20.42
Annual Milk Yield **(AMY)**	332	1546.34±19.86	1451.94	1616.78	17.62
Lactation Yield **(LYD)**	332	1840.45±34.33	1633.53	1972.98	26.60

2.3 Feeding and Management of the Farm:

The farm has a sub-tropical climate with monthly maximum temperature ranges between 31.6^{0}C to 19^{o}C and mean monthly minimum temperature ranges between 22.8^{0}C to 5.6 ^{o}C (DHM, 2012). In farm, limited grazing, tethering and cut-and-carry feeding are common. All of the buffaloes except pregnant are left in the pasture for grazing about 4-7 hours daily on local pasture land. During February to May, buffaloes were fed Berseem, Napier and Silage whereas during June to September, they were fed green Teosinte and Napier and from October to January, they were fed Oat, Berseem and Silage. During winter, when there is lean season of fodder crops, farm utilizes the silage, purchase rice straw and large amount of concentrates necessary to maintain farm ruminants (LDF, 2011). The breeding policy of the farm is both selective mating and artificial insemination whereas in later years farm has given emphasis to artificial insemination where buffaloes in estrus were inseminated with semen coming from genetically superior Murrah bull.

2.4 Statistical Model

The following fixed effect Linear model was used to study the effect of environmental factors i.e. year of calving, season of calving and dam's parity on productive traits under consider.

$Y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ijkl}$

Where:

Y_{ijkl} = the l-th record of buffalo calved in i-th year, j-th season and k-th parity

μ = overall mean

α_i = effect of i-th year of calving (1 = 2003-04, 2 = 2005-06, 3 = 2007-08, 4 = 2009-10, 5 = 2011-12)

β_j = effect of j-th season of calving (1= summer, 2 = winter, 3 = rainy)

γ_k = effect of k-th parity (1st and 2nd = early, 3rd and 4th = mid, 5th and above = advanced parity)

ε_{ijkl} = the residual term

2.5 Estimation of Genetic Parameters:

The data on milk production traits was analyzed for estimates of genetic parameters viz. heritability, genetic and phenotypic correlation coefficient by the method of paternal half sib correlation using the least-squares and maximum likelihood computer program of Harvey (1990).

Heritability was estimated through half-sib analysis in adjusted data. According to the statistical random model:

$Y_{ij} = \mu + s_i + \varepsilon_{ij}$

Y_{ij} = Adjusted observation on jth daughter from ith sire.

s_i = the effect of ith sire

ε_{ij} = the uncontrolled environment and genetic deviation attributed to the individuals in sire groups.

3.1 Environmental factors affecting Production traits

The environmental factors considered in evaluation of production traits were year of calving, season of calving and dam's parity. The overall least square means of lactation length **(LL),** daily milk yield **(DMY**), annual milk yield **(AMY)** and lactation yield **(LYD)** in the current study was found to be 362.77±4.49 days, 4.53±0.06 kg, 1540.34±17.86 kg and 1838.45±32.33 kg respectively (Table 3). Analysis of variance revealed that year of calving had significant effect on annual milk yield and daily milk yield ($P<0.05$), however, year of calving had no significant effect on lactation length and lactation yield. Another environmental factor, season of calving had significant effect on lactation length ($P<0.05$), annual milk yield and daily milk yield ($P<0.01$) but no effect on lactation yield. Dam's parity had significant effect on all production traits considered at 0.1% level of significance.

Dass & Sadana (2000) reported significant effect of season and period of calving and dam's parity on annual milk yield, lactation yield and lactation length of Murrah buffaloes. The significant influence of period of calving on annual milk yield observed in the current study was supported by similar findings on Murrah buffaloes (Sethi & Khatkar, 1997; Suresh et al. 2004; Thiruvenkadan et al. 2010). The significant influence of period of calving on lactation length observed corroborated with the previous findings on Murrah buffaloes (Suresh et al; 2004). In contrast, some of the studies, Ulaganathan et al., (1985) reported non-significant effect of period on lactation length. The lactation length and lactation milk yield were significantly ($P< 0.01$) affected by parity order in Nili-Ravi buffaloes (Chaudhry, 1992) which matches well with the findings of the present study.

The significant effect of year of calving over production traits might be due to the change in genetic constitution of herd over time. Also improved managerial conditions in the farm such as improvement of housing facilities like plastic wall around shed in cool season, construction of pond for wallowing construction of feed mill in farm could have influenced an impact for milk production traits. Season of calving, another environmental factor considered in the current study is also an important source of variation for milk production traits. Winter season calvers produce higher milk yield as compared to summer and rainy season calvers. The reason might be the availability of good quality fodder such as berseem and oat when they were in their peak lactation period. Another reason could be summer and rainy season calvers might face stressful, hot and humid climate shortly after calving. Similarly, Dam's parity had significant influence on all production traits considered in the present study. The significant influence of dam's parity on all production traits is due to the variation in maturity and functioning of lactation glands and physiological stability of the animals. Maximum value of milk production traits is found at mid parity due to the fully development of mammary gland cells and physiological stability of the animal as compared to early and advanced parity.

Thus, the significant effects of environmental factors on productive traits (as reflected by the present study) show that these environmental factors should be considered as an important criterion for selection to improve the overall productive performance of Murrah buffaloes. The breeding policy of the farm should consider these environmental factors for improving the life-time productivity of the animal and overall productivity of the herd.

Table 3: Effect of environmental factors (year of calving, season of calving and dam's parity) on productive traits of Murrah buffaloes.

LS Mean ± SE productive traits				
Factors	Lactation Length (days)	Daily Milk Yield(Kg)	Annual Milk Yield(Kg)	Lactation Yield(Kg)
Overall	362.77±4.49 (332)	4.53±0.06 (332)	1540.34±17.86 (332)	1838.45±32.33 (332)
Year of Calving				
2003-2004	367.31±9.32 (59)	4.38±0.12[b] (59)	1493.94±37.10[b] (59)	1797.88±67.16 (59)
2005-2006	367.36±8.22 (79)	4.73±0 .11[a] (79)	1595.07±32.70[ab] (79)	1933.59±59.19 (79)
2007-2008	366.34±8.60 (64)	4.38±0.11[b] (64)	1497.85±34.22[b] (64)	1803.59±61.93 (64)
2009-2010	356.65±9.34 (60)	4.42±0.12[ab] (60)	1513.69±37.16[ab] (60)	1781.41±67.26 (60)
2011-2012	356.17±8.44 (70)	4.74±0 .11[a] (70)	1601.15±33.60[a] (70)	1875.78±60.81 (70)
Level of Significance	NS	*(P<0.05)	*(P<0.05)	NS
Season of Calving				
Summer (Jan-April)	348.22±9.24[b] (56)	4.78±0.12[a] (56)	1616.78±36.79[a] (56)	1853.27±66.59 (56)
Rainy (May-August)	365.99±8.36[ab] (70)	4.23±0.11[b] (70)	1451.94±33.28[b] (70)	1751.14±60.24 (70)
Winter (Sep-Dec)	374.09±4.96[a] (206)	4.58±0.06[a] (206)	1552.31±19.73[a] (206)	1910.95±35.71 (206)
Level of Significance	*(P<0.05)	**(P<0.01)	**(P<0.01)	NS
Dam's parity				
Early (1-2)	339.76±6.07[b] (154)	4.26±0.08[b] (154)	1456.67±24.15[b] (154)	1633.52±43.72[b] (154)
Mid (3-4)	374.83±7.24[a] (101)	4.74±0.09[a] (101)	1601.92±28.83[a] (101)	1972.97±52.18[a] (101)
Advanced (≥5)	373.71 ±7.95[a] (77)	4.60±0.10[a] (77)	1562.43±31.65[a] (77)	1908.86±57.29[a] (77)
Level of Significance	***(P<0.001)	***(P<0.001)	***(P<0.001)	***(P<0.001)
R^2	0.075	0.133	0.140	0.133

* Significant at 5% (P< 0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS: Non-significant, LS: Least square means, SE: Standard error of means. Figures in the Parenthesis refer to the number of observations. Means superscripted by different letters differ significantly among themselves.

3.2 Heritability Estimates:

The heritability estimates of lactation length, daily milk yield, annual milk yield and lactation yield in the present study was found to be 0.11±0.11, 0.18±0.14, 0.23±0.15 and 0.19±0.14 respectively (Table 4). This model of heritability for milk production traits was calculated from paternal half sib correlation technique of 332 lactation records of Murrah buffaloes.

This estimate of heritability for lactation length as obtained in the present study was in agreement with the heritability estimate reported by Thevamanoharan et al. (2002) in Nili-Ravi buffaloes. The data of 1322 Nili-Ravi buffaloes were analyzed by animal model heritability technique and the value of heritability reported was 0.11±0.06. However, the heritability estimate reported by Pareek & Narang (2014) for first lactation length was relatively high than the present estimate. Lactation yield to be 0.09. The heritability estimate for annual milk yield was 0.23±0.15 (Table 4). This estimate was calculated from paternal half sib correlation technique of 332 lactation records. However, lower estimate of heritability had been reported by Thevamanoharan et al. (2002). He analysed the data of 1182 lactation records of Murrah buffaloes through animal model and estimated the heritability of annual milk yield as 0.01±0.02. The low heritability estimates of lactation length, lactation yield and daily milk yield as obtained in the present study suggested that these production traits are controlled

They analyzed the 435 first lactation records of murrah buffaloes by paternal half sib correlation technique and reported the value to be 0.21±0.15. The heritability estimate of lactation yield in the present study was 0.19±0.14. This estimate was calculated from paternal half sib correlation technique of 332 lactation records of Murrah buffaloes. This estimate was in agreement with Sethi & Khatkar (1997) who reported the heritability estimate for total lactation yield was 0.16±0.10. Similar value of heritability was reported by Tien& Tripathi (1990) in Murrah buffaloes. Meanwhile, Umrikar & Deshpande (1985) reported lower value of heritability for total lactation milk yield (first record).He analysed the data on 678 buffaloes through paternal half sib correlation technique and reported the value of heritability of

by factors other than additive gene action. These traits are largely under environmental influences. The low estimates of heritability for these production traits also suggested that either source of environmental variations have not been identified or certain factors are confounded with animal effect causing the additive gene component to be underestimated. Hence, improvement in these traits can be achieved through better feeding and management practices, alleviation of heat stress and better control of diseases. However, the moderate heritability estimate for annual milk yield (0.23±0.15) suggested that mass selection would be effective in bringing genetic improvement for this trait along with appropriate pedigree selection and progeny testing as suggested by Lasley (1978)

3.3 Genetic Correlation:

Results of this study revealed that the genetic correlation among production traits were positive and significant (Table 4). There exist a low genetic correlation between lactation length and annual milk yield 0.24±0.12 and lactation length and daily milk yield 0.23±0.15. However, there was high and significant positive genetic correlation between lactation length and lactation yield 0.74±0.25, lactation yield and annual milk yield 0.83±0.16, lactation yield and daily milk yield 0.84±0.17 and annual milk yield and daily milk yield 0.82±0.17. Sethi and Khatkar (1997) reported high and significant positive genetic correlation of 0.60±0.23 between lactation length and lactation yield ($P<0.01$). Similarly, Gajbhiye & Tripathi (1988) also reported high positive correlation between lactation yield and lactation length 0.95 in Murrah buffaloes. Another finding of Basu & Ghai (1978) reported lactation yield had significantly high and positive genetic correlation with annual milk yield ($P<0.01$).The high genetic correlation among different production traits indicated that these traits had strong genetic association. Thus, selection for the improvement in one trait will also result in the improvement in the other trait as many of the genes responsible for one production trait is also responsible for another trait (Lasley, 1978).

3.4 Phenotypic correlation

Results of this study revealed that phenotypic correlation among lactation length, annual milk yield and daily milk yield were positive but low (Table 4). The phenotypic correlation between lactation length and annual milk yield is 0.14, lactation length and daily milk yield is 0.15. However, the magnitude of phenotypic correlation among lactation length, lactation yield, annual milk yield and daily milk yield were high and positive. The phenotypic correlation of lactation length with lactation yield is 0.77, lactation yield with annual milk yield is 0.73, lactation yield with daily milk yield is 0.70 and annual milk yield with daily milk Yield is 0.95. Higher phenotypic correlation between lactation length and lactation yield were also reported in some earlier studies. Gajbhiye & Tripathi (1988) reported that the phenotypic correlation between lactation length and lactation yield was 0.95. Similarly, Dhara & Chakravarty (1995) reported the phenotypic correlation between lactation length and lactation yield was 0.70 and lactation yield and annual milk yield was 0.85. The strong phenotypic correlation between lactation length and lactation yield 0.77 as found in the present study indicated that both the traits have strong phenotypic correlation. This study showed that the animals which had long lactation length also produce high milk yield.

Table 4: Heritability (along diagonal), genetic (above diagonal) and phenotypic correlation (below diagonal) of production traits in Murrah buffaloes.

Traits	Lactation Length (LL)	Daily Milk Yield (DMY)	Annual Milk Yield (AMY)	Lactation Yield (LYD)
LL	**0.11±0.11**	0.23±0.15	0.24±0.12	0.74±0.25
DMY	0.15	**0.18±0.14**	0.82±0.17	0.84±0.17
AMY	0.14	0.95	**0.23±0.15**	0.83±0.166
LYD	0.77	0.70	0.73	**0.19±0.14**

4 CONCLUSIONS AND RECOMMENDATIONS

This study revealed that environmental factors such as year of calving, season of calving and dam’s parity had significant effect on all production traits considered in the current study. The significant effect of environmental factors on production traits suggested that these environmental factors should be used as an important criterion for selection to improve the overall productive performance of murrah buffaloes. Heritability estimates for all production traits were low (0.11±0.11) to moderate (0.23±0.15). These low estimates of heritability traits as obtained in the present study may be due to the non-genetic effects and the limitation in the size of data set. These low to moderate estimates of heritability also suggested us that there are limited scope for improvement in these traits through individual selection. Therefore, improvement in production traits is likely to be achieved by improved feeding and management practices, alleviation of heat stress and better control of diseases. Similarly, genetic and phenotypic correlation among productions traits were all positive ranging from moderate to high. This means the production traits are governed by similar set of genes .Therefore, improvement in one trait could be achieved by selecting the other trait which will improve the performance of the animal and overall productivity of the herd. Since there is relatively higher standard error associated with the parameters estimated, future projects should incorporate larger sample size to increase the reliability of the genetic parameters estimate and increase the genetic gain of the herd.

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