Pak. j. life soc. Sci. (2017), 15(2): 120-125 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

RESEARCH ARTICLE

Estimation of Genetic Parameters using Animal Model for Some Performance Traits of Nili-Ravi Buffaloes

Muhammad Khalid Bashir*, Muhammad Sajjad Khan[1], Shahid-ur-Rehman[2] and Muhammad Iqbal Mustafa[1]
Animal Breeding & Genetics, [2]Poultry Science, UAF, Sub Campus Toba Tek Singh, Pakistan
[1]Institute of Animal and Dairy Science, University of Agriculture, Faisalabad, Pakistan

ARTICLE INFO
Received: Jul 20, 2016
Accepted: Aug 15, 2017

Keywords
Animal Model
Heritability
Nili-Ravi buffaloes
Productive traits
Repeatability

***Corresponding Author:**
mkhalidbashir@uaf.edu.pk

ABSTRACT
The objective of this study was to estimate the genetic parameters of productive traits of Nili-Ravi buffaloes including milk yield (MY), lactation length (LL) and dry period (DP) for the identification of superior animals. For this purpose, data on 9003 lactation records of Nili-Ravi buffaloes from four institutional herds in Punjab, Pakistan were used for the present study. Model incorporating all known relationships was used for estimating variance components by ASREML and DFREML programs. The heritability evaluations for 305-day milk yield (305-day MY), total milk yield (TMY) and LL ranged from 9 to 23, 10 to 18 and 7 to 18 percent, for different parities. The overall heritability for 305-day MY, TMY, LL and DP, were 9, 10, 6 and 3 percent, respectively. The repeatability estimates for the 305-day MY, TMY, LL and DP were 35, 36, 22 and 9 percent, respectively. The low estimations for genetic parameters for all the production traits proposed that most of the observed variant in these traits was due to environmental settings or non-additive genetic effects. However high genetic variability indicates that there is an ample opening for the advancement of these productive traits while including in the future breeding programs.

INTRODUCTION

The Nili-Ravi buffalo originated during the sixties under a major policy decision of Livestock and Dairy Development Department of Government of Punjab considering Nili and Ravi as one instead of two independent breeds (Shah, 1991). The home tract of “Nili” breed is the Valley of Sutlej River, particularly Vehari, Pakpattan and Sahiwal Districts. It is one of the finest buffalo breeds in the world for milk production, body conformation and temperament. The home tract of other famous breed “Ravi” lies in Sandal Bar area of Ravi river valley in Faisalabad, Okara and Sahiwal Districts. In the second half of the last century, as communication increased and grazing lands started decreasing, the two breeds (Nili and Ravi) started mixing in a way that their distinctive characteristics merged with each other (Shah, 1991). The Nili-Ravi, thus, was recognized as a separate breed. It is now most common buffalo breed of Pakistan (37.7 million heads) and has a major contribution (34 million tonnes) in total milk production in the country (GOP, 2017). The Nili-Ravi is the most popular and most productive breed for the commercial setup. It has been exported to countries like China, Kenya, Egypt and Australia. Most of the genetic estimations of productive traits for buffaloes came from Government herds in India and Pakistan. Genetic parameters have been reported to vary considerably. Heritability (h^2) estimates for milk yield in Pakistani buffaloes (Khan et al., 1997a), estimated using a Multiple Trait Animal Model, ranged between 17-18%. Thevamanoharan et al. (2002) testified the heritability approximations for 305-day MY and TMY as 0.01±0.02 and 0.10±0.01, respectively. Previously, Cady et al. (1983) reported that sire variance for MY decreased as records were more restricted for LL of >60, >250 and the 305-day reduction was 4.3, 2.8 and 1.1%, respectively. The h^2 for three groups (lactation length of >60, >250 and 305-day) was 25.4, 17.9 and 7.1%, respectively. Estimates of repeatability for three groups were 26.5, 24.5 and 22.9 %, respectively. Khan (2000) also reported that lactation length adjustment procedure may affect the h^2 estimate. Unadjusted lactation milk yield was reported to be 9% heritable while adjusted milk yield was 12%. In Indian studies, h^2 for lactation milk yield had been reported between 0.08 to 0.65 (Jakhar el al., 2017). In Indian Murrah higher h^2 estimates for TLMY, 305MY were recorded as 0.392±0.114 and 0.348±0.118, respectively. Egyptian studies on genetic parameters for lactation milk yield also indicated a wide variation of h^2 estimates (0.05 to 0.30). Most of these studies utilized data from a single experimental herd. Heritability estimates from field recorded herds had only been reported for Italian buffaloes. Pilla and Moili (1992) reported that 305-day milk yield had heritability of 0.27. Later, Rosati and VanVleck (2002) reported lower estimates (0.14) using large data set on buffaloes. Catillo et al. (2001) reported estimate for milk yield of 0.19 for Italian buffaloes. Heritability and repeatability estimates for other traits even vary more widely. Similarly, there is no consensus on genetic correlations among various traits. For example, milk yield and lactation length have been reported to high genetic correlation of -0.15 (Peeva, 1997) and 1.0 (Mohamed et al., 1993). Difference of population, methodology, season and adjustment for other factors such as lactation length are commonly recognized reasons (Bashir et al., 2015). Breed improvement reforms in buffalo are very limited (Moioli et al., 2000) and with the exception of Italian studies, limited population data have been used to estimate the genetic trends.

As implementation of a breeding program in buffalos, requires genetic variation and estimation of genetic parameters such as heritability and repeatability. The genetic configuration of a population can be studied by bearing in mind the relative significance of heredity and environmental aspects affecting it. Estimation of genetic parameters for different productive traits of Nili-Ravi buffaloes in Pakistan have previously been based on the intra-sire regression of daughter on dam and covariance of paternal half-sibs, with pre-adjustment of fixed effects in the model. Breed improvement program in buffalo in Pakistan are new (Khan, 2001) but their expansion to more institutional and private herds requires estimates of genetic parameters and genetic correlation between economic traits.

The existing study aimed to estimate the heritability and repeatability of different productive traits in Nili-Ravi buffaloes and to suggest the plan for the future breeding plan for genetic improvement regarding dairy buffaloes in the country.

MATERIALS AND METHODS

Production records of Nili-Ravi buffaloes were obtained from the four Government herds of Livestock and Dairy Development Department of Punjab province; namely Livestock Experiment Station, Haroonabad, (LESHA) from 1979-2000; Livestock Experiment Station, Chak Katora, (LESCK) from 1971-2000; Livestock Experiment Station Khushab, (LESKH) from 1979-2000 and Livestock Production Research Institute, Bahadurnagar, (LPRIBN) from 1971-2000 for the present study. Production traits included 305-day milk yield (305-day MY), total milk yield (TMY), lactation length (LL) and dry period (DP).

Data on 305-day MY and TMY were based on actual weekly milk records. Lactations shorter than 60 days were excluded (5.2 %). Incomplete lactation records of buffaloes due to culling, abortion or diseases were also excluded from this study (Bashir et al., 2015).

Data was edited using the descriptive statistics the Statistical Analysis Systems and genetic parameters were estimated using Multiple Trait Animal Model. DFREML program was used to estimate genetic parameters (Meyer, 1997). Co-variance components were estimated with both uni-variate and bi-variate models. The basic model fitted was as follows:

$$Y = Xb + Zu + e$$

Where,

Y = Vector of observations,

X and Z = Design matrices for fixed and random effects, respectively,

b = Vector of fixed effects having herd-year of calving, calving season and age code (Iqbal, 1996),

u = Vector of individual animal breeding values

e = Vector of random error terms.

The bivariate model was used as under.

$$Y = (I_t \otimes X)b + (I_t \otimes Z_1)a + (I_t \otimes Z_2)p + e$$

Where, Y is a matrix of dependent variable having vectors of lifetime traits; b is vector of fixed effects; t is number of traits i.e. 2; $\otimes$ is Kronecker product, a, p, and e are random animal, permanent environment and temporary environment effects, respectively; X, Z_1 and Z_2 are incidence matrices for vectors b, a and p. Fixed effects included 94 herd-year combinations.

When combined analysis was performed for first five parities ‘u’ in the model also had permanent environment effect. The assumptions for explanations of various vectors and matrices were similar to univariate and bivariate analysis (Khan, 1998, 1997).

RESULTS AND DISCUSSION

Lactation milk yield

A heritability estimate of 305-day MY from univariate animal model was 0.10±0.02 for all lactation records (Table 1). The analysis of individual parities depicted increasing trend from 1st to 5th parities. The h^2 was highest (0.23±0.11) for 5th parity. When combined analysis was performed for 1st five parities (0.10±0.2) or all ten parities (0.09±0.02), estimate was the same. Heritability estimate in the present study was to some extent lower than the earlier studies for Nili-Ravi in Pakistan where estimate ranged between 0.14 to 0.18 or

Indian Nili-Ravi (0.15 to 0.19), Bulgarian (0.12), Egyptain (0.13), Italian (0.14), Murrah (0.14) and Surti (0.17) buffaloes (Khan et al., 1997a, b; Tailor et al., 1992a; Pareek and Narang, 2014). The heritability of milk yield increased with the increase in lactation number. In Simmental and Brown Swiss cattle, Emmerling et al. (2002) reported the h^2 for 1st, 2nd and later parities were 0.20, 0.23 and 0.25, respectively. The change between first and later lactation for lactation milk yield were not large. The increase in h^2 across parities had also been reported for Ayrshire, Guernsey, Holstein and Jersey in Canada (Jorjani, 2000). Yang et al. (2005) also reported the increase in h^2 of milk yield from 1st to 6th parity. In present study, error variance did not significantly increase across the parities, which ultimately resulted in non-significantly different heritability estimates across the parities.

The repeatability estimates for combined analysis of all parities were found 0.35 and 0.36 for 305-day MY and TMY, respectively (Table 1) which were same when data were restricted to first five parities. Repeatability estimates obtained in this study were similar to the previous studies on Murrah, Nili-Ravi, Egyptian, Surti and Italian buffaloes (Khan et al., 1996; Hamed, 1994; Jamuna et al., 2015; Pilla and Moioli, 1992; Morammazi et al. 2010; Jakhar et al. 2017). These estimates suggested that culling for the milk yield could be done on a first lactation record to improve the performance of herd.

Lactation length

The h^2 estimate for the lactation length was 0.06±0.017 (Table 1). Low h^2 for lactation length obtained in the present study are in conformity with the previous findings on Nili-Rani and Murrah buffaloes (Khan, 1997; Salah-ud-Din, 1989; Dutt and Taneja, 1995; Rana et al., 2002; Jakhar et al., 2017). The h^2 estimates from these studies ranged from 0.05±0.13 to 0.07±0.07.

Repeatability of lactation length was 0.20 when 1st five lactations were used and 0.21 when all lactations were included in the data set (Table 1). The present repeatability estimate for lactation length is similar to previous reports (Khan, 1997; Khan and Chaudhry, 2000) in Pakistani buffaloes. A very low estimate of 0.04 for Murrah was reported by Sesana et al. (2014) but later studies (Pareek and Narang, 2014) reported higher estimates (0.17 to 0.25) for the Murrah breed. The estimates of repeatability in Egyptian buffaloes were even higher (0.21 to 0.45) as reported by Ashmawy (1991) and Ayyat et al. (1996) and in cattle by Ayalew et al. (2017).

Dry period

The h^2 estimate for dry period in present study based on 7283 lactation records was 0.03±0.01 (Table 1). The h^2 estimate obtained in the present study is similar to the Pakistani (0.07 to 0.09), Egyptian (0.07 to 0.13) and Indian buffaloes (0.08 to 0.11) (Thevamanoharan et al., 2002; Aziz et al., 2001; Khan, 1997; Ayyat et al., 1996; Dutt and Taneja, 1995; Tailor et al., 1992b). The h^2

Table 1: Hertability (h^2) and repeatability (r) estimates with standard errors, additive (σ^2_a), phenotypic (σ^2_p), environmental variances and coefficient of variation (CV) for the productive traits

Traits	N	h^2±SE	σ^2_a	σ^2_p	σ^2_e	CV	r
305-day milk yield (kg)							
Parity 1	2050	0.136±0.04	39767.98	291522.90	251754.9	32.08	
Parity 2	1797	0.160±0.05	58461.64	363730.27	305268.6	34.28	
Parity 3	1533	0.145±0.05	48835.93	335561.31	286725.4	32.36	
Parity 4	1192	0.209±0.06	66499.53	317870.19	251370.7	32.36	
Parity 5	875	0.235±0.11	77007.66	326433.25	249425.6	32.50	
upto 5th parity	7446	0.105±0.02	35501.40	337255.50	215886.3	33.34	0.359
All parities	9003	0.095±0.02	31908.85	335519.57	219583.0	33.49	0.345
Total lactation yield (kg)							
Parity 1	2050	0.136±0.04	58692.00	431420.51	372728.5	36.25	
Parity 2	1797	0.151±0.05	74758.78	493968.18	419209.4	37.41	
Parity 3	1533	0.158±0.06	74009.11	468391.50	394382.4	35.83	
Parity 4	1192	0.186±0.06	80433.88	432256.58	351822.7	35.61	
Parity 5	875	0.183±0.11	77444.34	423032.91	345588.6	35.05	
upto 5th parity	7446	0.109±0.03	51568.77	469023.25	292767.3	36.84	0.375
All parities	9003	0.103±0.02	47959.47	463693.05	296035.0	37.00	0.361
Lactation length (days)							
Parity 1	2050	0.061±0.04	432.07	6976.67	6544.6	29.33	
Parity 2	1797	0.074±0.04	489.66	6616.98	6127.3	28.74	
Parity 3	1533	0.065±0.05	383.73	5835.74	5452.0	27.11	
Parity 4	1192	0.184±0.07	1113.49	6025.87	4912.4	28.07	
Parity 5	875	0.118±0.08	636.01	5740.77	5104.7	27.58	
upto 5th parity	7446	0.071±0.02	471.44	6621.11	5288.8	28.93	0.201
All parities	9003	0.064±0.02	417.03	6515.57	5170.8	29.01	0.206
Dry period (day)	7283	0.033±0.01	551.01	16358.42	14886.7	49.55	0.090

estimated by four methods for first dry period were 0.14, 0.12, 0.09 and 0.09, respectively under univariate and multivariate REML analyses. The low magnitude of h^2 clearly indicated that this is influenced by the environmental factors and this trait may be improved by better feeding and management practices (Jakhar et al., 2017; Yadav and Singh, 2016).

The repeatability estimates for the dry period was 0.09 in the present study. Repeatability estimates for dry period in Pakistani buffaloes have been reported to range between 0.09-0.20 (Thevamanoharan et al., 2002; Salah-ud-Din, 1989). For Indian breeds estimates have also been higher (0.10 to 0.20) than the present study (Jamuna et al., 2015). Metry et al. (1994) reported dry period to have repeatability of 0.22 in Egyptian buffaloes while Ashmawy (1991) and Ayyat et al. (1996) reported estimates of 0.22 and 0.28, respectively.

Conclusions

Genetic parameters estimated for various productive traits in the present study were in the generally reported range of parameters for buffaloes. Milk yield was lowly heritable (10%) with high repeatability (35%). Genetic control of milk yield and lactation length was different for different parities. Genetic base needs to be widened to increase the genetic variation. Genetic selection of young bulls under artificial insemination program would be one segment requiring priority for better genetic gain.

Acknowledgements

Authors are thankful to the Directorate of L&DD, Punjab and University of Agriculture, Faisalabad, Pakistan for the availability of Data and facilities to complete this study.

Authors' contribution

Research work was completed by MKB with the help of MSK and data collection and provision of literature by MIM and SUR and their valuable suggestion regarding design of experiment and data analysis.

REFERENCES

Ashmawy AA, 1991. Repeatability of productive traits in Egyptian buffaloes. Journal of Animal Breeding and Genetics, 108: 182-186.

Ayalew W, M Aliy and E Negussie, 2017. Estimation of genetic parameters of the productive and reproductive traits in Ethiopian Holstein using multi-trait models. Asian-Australasian Journal of Animal Sciences, 30:1550-1556.

Ayyat MS, IF Marai and OM El-Shafie, 1996. Factors affecting adjusted milk yield for lactation length in Egyptian buffaloes and their pattern of inheritance. Indian Journal of Animal Science, 66: 607-613.

Aziz MA, SJ Schoeman, GF Jordaan, OM El-Chafie and AT Mahdy, 2001. Genetic and phenotypic variation of some reproductive traits in Egyptian buffalo. South African Journal of Animal Science, 31: 195-199.

Bashir MK, MS Khan, M Lateef, MI Mustafa, MF Khalid, S Rehman and U Farooq, 2015. environmental factors affecting productive traits and their trends in Nili-Ravi buffaloes. Pakistan Journal of Life and Social Sciences, 13: 137-144.

Cady RA, SK Shah, EC Schermerhorn and RE McDowell, 1983. Factors affecting performance of Nili-Ravi buffaloes in Pakistan. Journal of Dairy Science, 66: 578-586.

Catillo G, B Moioli and F Napolitano, 2001. Estimation of genetic parameters of some productive and reproductive traits in Italian buffalo. Genetic evaluation with BLUP-animal model. Asian-Australasian Journal of Animal Sciences, 14: 747-753.

Dutt T and VK Taneja, 1995. Genetic studies on first lactation length, first dry period and first calving interval in Murrah buffaloes. Indian Journal of Animal Science, 65: 339-340.

Emmerling R, M Lindauer and EA Mantysaar, 2002. Multiple lactation random regression test-day model for Simmental and Brown Swiss in Germany and Austria. Proceedings of Interbull Open Meeting, Interlaaken, 26-27 May/Bulletin 29th International Bull Evaluation Service, Uppsala, pp: 111-117.

GOP (Government of Pakistan), 2017. Economic Survey of Pakistan. Economic Advisor Wing, Finance Division, Govt. of Pakistan, Islamabad, Pakistan.

Hamed MK, 1994. Age and days open correction factors and repeatability estimates for yield and interval traits in Egyptian buffaloes. Egyptian Journal of Animal Production, 31: 163-177.

Iqbal J, 1996. Sire evaluation on partial lactation records in Sahiwal cattle and Nili-Ravi buffaloes. PhD Thesis, University of Agriculture, Faisalabad, Pakistan.

Jakhar V, AS Yadav and SS Dhaka, 2017. Estimation of genetic parameters for production and reproduction traits in Murrah Buffaloes. International Journal of Current Microbiology and Applied Sciences, 6: 4297-4303.

Jorjani H, 2000. Impact of input data quality on national genetic evaluations. Journal of Dairy Science, 83 (Suppl 1): 53.

Jamuna V, AK Chakravarty, A Singh and CS Patil, 2015. Genetic parameters of fertility and production traits in Murrah buffaloes. Indian Journal of Animal Research, 49: 288-291.

Khan MA, G Mohiuddin and K Javed, 1996. Inheritance of some performance traits in Nili-Ravi buffaloes. Proceedings of 2nd Asian Buffalo Congress, October. 9-12, Manila. Philippines (http://agris.fao.org/agris-search/search.do?recordID=PH1999101177; Retreived on 16 Dec 2106).

Khan MS, 1998. Animal model evaluation of Nili-Ravi buffaloes. Proceedings of 6th World Congress on Genetics Applied to Livestock Production, Armidale, NSW, Australia.

Khan MS, 2000. Lactation length adjustment in Nili-Ravi buffalo- A new procedure. Buffalo. Newsletter, 14: 4-5.

Khan MS, 2001. Development strategies for genetic evaluation of cattle and buffaloes in Pakistan. ACIAR, 108: 57-62.

Khan MS and HZ Chaudhry, 2000. Lactation length and its behaviour in Nili-Ravi buffaloes. Journal of Veterinary Science, 20: 81-84.

Khan MS, GE Shook, AA Ashghar, MA Chaudhry and RE McDowell, 1997a. Genetic parameters of milk yield and adjustment for age at calving in Nili-Ravi. Asian-Australasian Journal of Animal Sciences, 10: 505-529.

Khan MS, KZ Gondal, SH Raza and AA Ashghar, 1997b. First lactation genetic parameters of buffaloes under multiple trait animal model. Agricultural Science (Oman), 2: 27-30.

Sesana RC, F Baldi, RRA Borquis, AB Bignardi1, NA Hurtado-Lugo, L El-Faro, LG Albuquerque and H Tonhati, 2014. Estimates of genetic parameters for total milk yield over multiple ages in Brazilian Murrah buffaloes using different models. Genetics and Molecular Research, 13: 2784-2795.

Metry GH, HA El-Rigalaty, JC Wilk and RE McDowell, 1994. Factors affecting the performance of Egyptian buffalo. Mansoura University Journal of Agricultural Sciences, 32: 827-841.

Meyer K. 1997. User notes of DFREML. Version 3.0.

Mohamed M, AM Kawther and AS Khattab, 1993. Genetic relationship of age and weight at first calving with first lactation milk yield in Egyptian buffaloes. Buffalo Bulletin, 12: 38-46.

Moioli B, J Maki-Hokkonen, S Galal and M Zjalic (Eds). 2000. Animal Recording for Improved Breeding and Management Strategies for Buffaloes. Proc. Workshop. Bled, Slovenia (16-17 May, 2000), ICAR Technical Series 4. Rome, Italy. (https://cgspace.cgiar.org/handle/ 10568/10321; Retrieved on 24 Dec 2016).

Morammazi S, R Torshizi, Y Rouzbehan and MB Sayyadnejad, 2010. Estimates of genetic parameters for production and reproduction traits in Khuzestan buffalos of Iran. Italian Journal of Animal Science, 6: 421-424.

Pareek NK and R Narang, 2014. Genetic analysis of first lactation persistency and milk production traits in graded Murrah buffaloes. Buffalo Bulletin, 33: 432-436.

Peeva TZ, 1997. Genetic parameters of selection traits in buffaloes. Proceedings of 5th World Buffalo Congress held at Italy, pp: 506-509.

Pilla AM and BM Moioli, 1992. Genetic evaluation of buffaloes for milk yield using the animal model. Zootecnica e Nutrizione Animale, 18: 207-218.

Rana ZS, DS Dalal, ML Sangwan and CP Malik, 2002. Performance status of Murrah buffaloes for first lactation traits-A review. Proceedings of 7th World Congress on Genetics Applied to Livestock Production, Montpellier, France, pp: 1-3.

Rosati A and LD VanVleck, 2002. Estimation of genetic parameters for milk, fat, protein and mozzarella cheese production in the Italian river buffalo population. Livestock Production Science, 74: 185-190.

Salah-ud-Din, 1989. The genetic analysis of production and reproduction traits in Nili-Ravi buffalo in Pakistan. PhD Thesis, The Ohio State University, Columbus, USA.

Sesana RC, F Baldi, RRA Borquis, AB Bignardi, NA Hurtado-Lugo, L El Faro, LG Albuquerque and H Tonhati, 2014. Estimates of genetic parameters for total milk yield over multiple ages in Brazilian Murrah buffaloes using different models. Genetics and Molecular Research, 13: 2784-2795.

Shah SK, 1991. Buffaloes of Pakistan. Pakistan Agricultural Council, Islamabad, Pakistan, pp: 3-4.

Tailor SP, LS Jain and M Tusavara, 1992a. Analysis of milk yield, lactation length and dry period in Surti buffaloes. Indian Journal of Animal Science, 62: 479-481.

Tailor SP, LS Jain and M Tusavara, I992b. Genetic studies on lactation length and dry period in Surti buffaloes. International Journal of Animal Science, 7: 115-117.

Thevamanoharan K, W Vandepitte, G Mohiuddin and K Javed, 2002. Animal model heritability estimates for various production and reproduction traits of Nili-Ravi buffaloes. International Journal of Agriculture and Biology, 4: 357-361.

Tulloh NM and JHG Holmes. 1992. Buffalo Production. Elsevier Publication, London, UK.

Yadav TB and CV Singh. 2016. estimation of genetic parameters of first lactation and herd life traits by different animal models in Murrah buffaloes. Animal Molecular Breeding, 6: 1-12.

Yang RQ, HY Ren, LR Schaeffer and SZ Xu, 2005. Estimation of genetic parameters for lactational milk yield using two-dimensional random regression on parities and days in milk in Chinese Simmental cattle. Journal of Animal Breeding and Genetics, 122: 49-55.