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Journal of Dairy, Veterinary & Animal Research

Research Article

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Genetic evaluation of post-weaning growth traits in teddy goats

Abstract

The study was carried out to genetically evaluate post weaning growth traits in Teddy goat and for this purpose data available on 18702 kidding and performance records of 5150 Teddy goats and progeny of 382 sires maintained at Livestock Experiment Stations

i. Rakh Ghulaman, District Bakkhar (1983-2008)

ii. Rakh Khariewala District Layyah (1971-2008) and

iii. Chak Katora, District Bahawalpur (1975-2008) Punjab, Pakistan were analyzed.

Restricted Maximum likelihood (REML) procedure fitting an Individual Animal Model was used for variance component estimation. Estimates of breeding values for various performance traits were calculated by using BLUP. For these purposes WOMBAT software was used. The heritability estimates for weight at six months (6MW), weight at nine months (9MW), yearling weight (YW), post-weaning daily gain at six (ADG1), nine (ADG2) and twelve months (ADG3), were 0.19±0.42, 0.09±0.01, 0.21±0.32, 0.17±0.42, 0.12±0.02 and 0.15±0.01, respectively. The estimates of genetic correlations between different growth traits varied from 0.61 between 6MW & ADG3 to 0.97 between 6MW and ADG1. The genetic trend in 6MW, 9MW and YW had no significant trend and fluctuated in the vicinity of zero. It is envisaged from the present study that over the 34 years period selection remained ineffective to bring the desired changes and it will remain so if random use of breeding animals is practiced.

Keywords: genetic correlations, genetic trends, estimated breeding values, heritability

Volume 2 Issue 2 - 2015

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Received: March 19, 2015 | **Published:** May 14, 2015

Abbreviations: REML, restricted maximum likelihood; BLUP, best linear unbiased prediction; EBVs, estimated breeding values

Introduction

The potential of genetic improvement largely depends on genetic variation of the trait and its relationship with the other traits. Knowledge of repeatability, heritability and correlations among various traits is essential for formulating efficient breeding plan and selection strategies. These genetic parameter estimates help in the determination of the selection method, to forecast direct and correlated response to selection, choosing a more realistic breeding system to be adopted for the future improvement as well as in the estimation of genetic gain. Trend lines can convey a rapid assessment of a breeder's selection success in the previous generations. Breeders involved with larger herds can compare alternative methods of selection or management with the use of trend lines. The trend lines can be helpful in reinforcing selection and management goals established by a breeder.[1] However, a need for changes in selection methods and/or managmental practices may be as a result of such trend lines. When trend lines deviate from the anticipated results it is clear that the response to selection were not appropriate or too much optimistic expectations were made. The actual amount of selection applied in the scheme is also demonstrated by these trend lines.[2] In the past, some sporadic studies have been conducted on Teddy goats but genetic parameters vary with location, time period, size of data set and method used for their estimation, therefore, the present study has been designed to

a. Estimate genetic parameters viz. heritability of post weaning growth traits and genetic correlations among these traits.

b. Estimating breeding values of different post-weaning growth traits and

c. To study the genetic trends in present flock so as to generate information, this will help in future development of breeding plans for genetic improvement in the breed.

Materials and methods

Source of data

Data available for the analysis were collected from the breeding flock of Teddy goats maintained at three locations:

A. Livestock Experiment Station Rakh Ghulaman, District: Bakkhar (1984-2008)

B. Livestock Experiment Station, Rakh Khariewala District: Layyah (1972-2008)

C. Livestock Experiment Station Chak Katora, District: Bahawalpur (1974-2008)

The growth traits used for the analysis were 6month weight (6MW), 9-month weight (9MW), yearling weight (YW), post-weaning daily gain at six months (ADG1), post-weaning daily gain at nine months (ADG2), post-weaning daily gain at twelve months (ADG3).

The available recorded information pertaining to birth type, sex, weight at six and nine months and yearling weight was used for estimating genetic parameters[3] of different performance traits.

Location of the farms

The Livestock Experiment Station, Rakh Ghulaman District Bhakhar originally started as "Common Wealth Livestock Development Farm" in 1951. The Livestock Experiment Station at Rakh Khariewala, District Layyah in the Punjab province of Pakistan was established in 1962. The Livestock Experiment Station at Chak Katora, District: Bahawalpur in the Punjab province was established in 1974-75 and is working under Directorate Livestock Farms, however from 2005 the financial and administrative control is with Buffalo Research Institute, Pattoki District Kasur. It is located at a distance of 310 kilometers from the provincial capital Lahore on south-western side. The primary purpose of establishing these farm being the conservation and propagation of different livestock breeds in addition to produce candidate bull calves and quality Rams and Bucks. The average rainfall is 120 mm. Temperatures in summer range from 25°C to 46°C, while winter is bit cooler with temperature ranging from 9°C to 22°C. The average rainfall is very low with recordings of 10cm in the whole year.

Management

Management and feeding practices at the experiment stations were almost identical and have been more or less the same since the introduction of Teddy goats. The adult animals were maintained in open enclosures throughout the year with sufficient area being covered to offer enough shade and shelter during the extremes of weather. Normal practice was to allow animals to graze for 7-9hours daily on range except during harsh weather, wherein the animals were retained inside the sheds. The normal practice was to allow the animals to graze daily on leafy trees and horny bushes for 5-6hours and on green fodder for 2-3hours daily.

Selection of breeding stock and breeding policy

Teddy goats were introduced at LES Rakh Ghulaman in 1984 when Teddy goats were purchased from different areas of Punjab to establish nucleus herd at the farm, while at LES Khariewala and LES Chak Katora introduction of Teddy goats took place in 1963 and 1972, respectively. It has been a general practice to select the does mainly among those produced at the farm, with primary emphasis on body conformation and breeds characteristics, however during 1972-73 and 1985-86 goats were also purchased from outside area. Selection of the bucks was based on the body conformation and breed characteristics. Emphasis on growth characteristics and body size of a buck for selection were also given emphasis. A scheme entitled Goat Development Centre at Rakh Khariewala was started in 1972-73 and in addition to existing flock 100 more does and 5 bucks were added to already existing flock. Teaser bucks were used to detect the does in heat, color bags were tied to bellies of teaser bucks for recognizing the does mounted by teasers. The does after being detected in heat by the teaser bucks were exposed for natural mating with the breeding bucks. For breeding purpose it was a normal practice to select 5-6 bucks in a year. As Teddy goat is a meat purpose goat, therefore, focus in the breeding plan was on chevon production. As considerable number of Teddy goats exhibit estrous round the year, so kid crop has also been produced during all the four seasons.

General management and feeding practices

Management and feeding practices at the experiment stations were almost identical and have been more or less the same since the introduction of Teddy goats. The adult animals were maintained in open enclosures throughout the year with sufficient area being covered to offer enough shade and shelter during the extremes of weather. Normal practice was to allow animals to graze for 7-9hours daily on range except during harsh weather, wherein the animals were retained inside the sheds. In scarcity period animals were provided a concentrate mixture. The breeding females were also provided with concentrate mixture 45days before breeding for flushing and 60days after parturition at the rate of 250 to 500grams per doe. Breeding bucks were also offered a concentrate mixture at the rate of 500-750grams during breeding.

The young kids were mostly kept indoors up to one month of age and remained with their dams to suckle freely from evening to morning of next day, when does were again taken out to graze. After one month of age the kids remained with their mothers for 24hours up to weaning. The weaned kids were transferred to new pens for rearing. Feed composition was different in different periods of the year as it depended mostly on the availability of fodder crops. Green Jowar (Andropogon sorghum), Maize (Zea mays), Guara (Cyamposis psoraliodes), Moth (Phaseolus aconitiflovis) and Cow peas (Vigna sinensis) were fed during the months of May to October. The Bajra Napier hybrid, Sorghum and Sudan grass hybrid (Sudex) and Teo-sinte were introduced at these farms were introduced from 1977-1980. During winter and spring Berseem and Lucern were major fodder crops for grazing. The concentrate mixture consisted of crushed gram (Cicer arietium), Barely (Hordeum vulgare), oats (Avena sativa), wheat bran and oilseed cakes (cottonseed, rapeseed).

Description of data set

Available data had the information of the doe, the buck, kid identities, birth date, birth weight, monthly weight recordings, date of service and date of kidding. Derived variables included weight at six and nine months, yearling weight, post weaning weight gains. The objectionable/ambiguous were removed from the data. Initially 20455 breeding records of 5545 does sired by 406 bucks were available.

Editing criteria

Data of Teddy goats on different traits were analyzed statistically in order to estimate the magnitude of various environmental and genetic sources of variation in these traits. Different types of edits were made to the data in order to get rid of the outliers before analysis. *Data* with any recorded abnormality were also excluded from the analysis. For data entry and manipulation MS Excel spread sheets were used.

Estimation of genetic parameters

The genetic parameters viz. heritability and genetic and phenotypic correlations were estimated by using Restricted Maximum Likelihood procedure outlined by Patterson & Thompson[4] fitting an Individual Animal Model. An attempt was made to reduce the bias as a result of selection and non-random mating by including all available pedigree in the analysis.[4] The convergence criterion (variance of function values -2 log likelihood) for various genetic parameters was $1x10^{-8}$.

Heritability estimation

For heritability estimation the mathematical model assumed was

Citation: Kuthu ZH, Javed K, Ahmad N, et al. Genetic evaluation of post-weaning growth traits in teddy goats. *J Dairy Vet Anim Res.* 2015;2(2):66–71. DOI: 10.15406/jdvar.2015.02.00032

as follows:

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

Where, Y_{ijk} is measurement of a particular trait, μ is population mean, F_i is Fixed effects observed to be significant from the initial analyses, A_j is Random additive genetic effect of j^{th} animal with mean zero and variance σ^2A, e_{ijk} is Random error with mean zero and variance σ^2e

The heritability was calculated by the formula:

$$Heritability\left(h^2\right) = \frac{\sigma^2 A}{\sigma^2 P}$$

Genetic and phenotypic correlations

Estimation of genetic and phenotypic correlations between various performance parameters was carried out after analyzing these parameters statistically by bivariate analysis. For the purpose bivariate analysis were carried out using individual animal model REML technique.[4] The fixed effects for various performance traits in this analysis were same as considered in the univariate analysis

The various parameters estimated from the bivariate analysis were:

$$Heritability\left(h^2 i\right) = \frac{\sigma^2_{Ai}}{\sigma^2_{pi}}$$

$$Phenotypic\ correlation\left(r_p\right) = \frac{Cov_{pi.pj}}{\sigma_{pi}.\sigma_{pj}}$$

$$Genetic\ correlation\ \left(r_G\right) = \frac{Cov_{pi.pj}}{\sigma_{pi.}\sigma_{pj}}$$

$$Environmental\ correlation\ \left(r_E\right) = \frac{Cov_{Ei.Ej}}{\sigma_{Ei.}\sigma_{Ej}}$$

Where, h^2_i: heritability of ith trait; σ^2_{Ai}: additive genetic variance for the i^{th} trait; σ^2_{pi}: phenotypic variance for ith trait; σ^2_{Ei}: residual variance for the i^{th} trait; $Cov_{pi.pj}$: phenotypic covariance for the traits i and j; $Cov_{Ai.Aj}$: additive genetic covariance for the traits i and j; $Cov_{Ei.Ej}$: residual covariance for the traits i and j.

All these analyses were performed by the Restricted Maximum Likelihood method (REML) using the software Wombat.[5]

Estimation of breeding values and genetic trends

Breeding values of animals for various growth traits were estimated by best linear unbiased prediction (BLUP) procedure as outlined by Henderson.[6] The DFREML set of computer programmes also generates Estimated Breeding Values (EBVs) as a by-product. Breeding values thus estimated were fitted in a fixed effect model having year of birth as the only fixed effect. The least squares solutions of breeding values were drawn against year of birth to depict the genetic trend. The REML programme used above also generates Estimated Breeding Values. After estimating breeding values they were fitted in a fixed effect model which had only year of birth as the only fixed effect. Genetic trends were depicted by drawing the least squares solutions of breeding values against the year of birth.

Results and discussion

Data available on 18702 kidding and performance records of 5150 Teddy goats and progeny of 382 sires maintained as separate flocks at Livestock Experiment Stations

i. Rakh Ghulaman, District Bakkhar (1983-2008)

ii. Rakh Khariewala District Layyah (1971-2008) and

iii. Chak Katora, District Bahawalpur (1975-2008) Punjab, Pakistan were utilized in the present study.

Genetic sources of variation on post weaning growth traits were studied. An attempt was made to calculate estimated breeding values (EBVs) and genetic trends in order to assess the previous selection strategies.

Heritability of growth traits

The estimates of heritability for different growth traits obtained in the present study are presented in Table 1.

Table 1 Heritability estimates for some growth traits in teddy goats

Growth Trait	No. of records	Dams	Sires	Heritability
6WT Months	14596	4879	377	0.19±0.42
9WT Months	14498	4848	375	0.09±0.01
Yearling Weight	12324	3770	357	0.12±0.01
PtWDG at Six Months	14596	4879	377	0.17±0.42
PtWDG at Nine Months	14498	4848	375	0.12±0.02
PtWDG at Twelve Months	12324	3770	357	0.15±0.01

Weight at six months: The estimates of heritability for 6MWmonths was 0.19±0.42 which was based on the analysis being performed on the records of 14596 kids which were born to 4879 does sired by 377 bucks, The medium estimates of heritability for the trait were supported by the findings of Rashidi et al.[7] (0.19) in Markhoz goat breed in Iran. Lower estimates of heritability ranging from 0.06±0.02 to 0.17 in different goat breeds were reported by Boujenane & El Hazzab.[8] Roy et al.[9] Hermiz et al.[10] Ekambaram et al.[11] Gowane et al.[12] Higher estimates of heritability ranging from 0.25±0.06 to 0.6 were reported by Schoeman et al.[13] Mourad & Anous.[14] Thiruvenkadan et al.[15] Faruque et al.[16] Roy et al.[17]

Weight at nine months: The estimates of heritability for weight at nine months was 0.09±0.01 which was based on the analysis being performed on the records of 14498 kids which were born to 4848 does sired by 375 bucks. The estimates of heritability were in agreement with the findings of Gowane et al.[12] (0.09±0.03) in Sirohi goat. In a very few studies carried on the trait heritability estimates have varied from a low of 0.09±0.01 to 0.45. Rashidi et al.[7] (0.33) in Markhoz goat breed in Iran, while Schoeman et al.,[13] (0.4) in Boer goats and Faruque et al.[16] (0.45) in Black Bengal. Lower heritability estimates for the trait in the range of 0.11±0.04 to 0.298±0.114 were reported by Snyman &

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Olivier,[18] Roy et al.,[9] Hermiz et al.,[10] Thiruvenkadan et al.[15] Alade et al.[19] Ekambaram et al.,[11] Roy et al.,[17] The differences in heritability estimates of the present study and those of other workers discussed above may be attributed to the breed difference, environment, feeding, management, number of observations and the method of estimation of heritability. The medium estimates of heritability for six month weight in present study indicate that trait is under effect of environment also. Therefore there is space for improvement in the trait by minimizing the environmental sources of variation by improving managmental practices; however some pressure can be applied on the trait, when animals are selected to be parents of next generation.

Yearling weight: The estimates of heritability for yearling weight was 0.12±0.01 which was based on the analysis of 12324 records of the animals with progeny records of 3770 dams sired by 357 bucks, *The result*s of present study were in accordance with the findings of Hyder et al.,[20] (0.12±0.06) in Teddy goats. The genetic trend for the yearling weight remained static for the last 6 years indicating no directional selection for the trait. Shafiq & Sharif[21] in a study on crossbred (Teddy x Beetal) flock of goats reported, that heritability estimates for the trait was 0.17±0.09, being higher and not in accordance with the findings of present study. In Beetal goat breed in Pakistan lower estimates of heritability (0.07±0.18 and 0.09±0.032) for the yearling weight were reported Shafiq & Sharif,[21] Ali & Khan[22] Low heritability estimates for yearling weight has been reported in different goat breeds from different countries by scientist ranging from 0.07 to 0.11±0.03 Zhou et al.[23] Sawalha &Tabbaa.[24] Gowane et al.[12] Higher estimates of heritability than the present study ranging from 0.18±0.06 to 0.88 were reported by Mukundan & Bhat[25] Madeli & Patro.[26] Jin & Zhang,[27] Bishop & Russel,[28] Snyman & Olivier[18] Schoeman et al.,[13] Rashidi et al.,[29] Rashidi et al.,[7] Roy et al.,[9] Hermiz et al.,[10] Thiruvenkadan et al.,[15] Ekambaram et al.,[11] Faruque et al.,[16] Roy et al.[17]

Post-weaning daily gain: The estimate of heritabilities[30] for post-weaning daily gain at six, nine and twelve months of age were 0.17±0.42, 0.12±0.02 and 0.15±0.01 based on the records of 14596, 14498 and 12324 records of kids born of 4879, 4848 and 3770 does sired by 377, 375 and 357 bucks, respectively. The estimates of heritability for post-weaning daily gain in different goat breeds ranged from a very low 0.0045 in Angora goat breed to very high estimates of 0.86 Gerstmayr[31] Shafiq & Sharif[21] in Beetal goats. In Teddy goats, a low estimate of heritability (0.10±0.08) for post weaning daily gain was reported by Shafiq & Sharif[21] which was comparable with the findings of present study. Gowane et al.[12] reported low heritability estimates of 0.04±0.02 for daily weight gain at six months in Sirohi goat breed, while Mohammadi et al.,[32] reported that heritability estimates for daily weight gain from three to six months of age was 0.08±0.02 in Raeini Cashmere goat. Six month weight, post-weaning daily gain at six and twelve months had medium heritability estimates which suggest that these traits offer scope for genetic selection.

In general the growth traits in ovine and caprine are bracketed as moderately heritable traits, although there are enough evidences of high heritability estimates of growth traits in the literature in these species. The factors responsible for this difference may be size of data set used, the methods of estimation of heritability, the strong environmental influence, breed differences, effect of inbreeding, locations, time periods and other managmental factors. The low estimates of heritability in some traits may also suggest that these traits were probably not under the influence of additive gene action and variation due to environmental factors was more pronounced. This suggests that for the improvement in the flock special methods should be used for selection and mating.

Phenotypic, genetic and environmental correlations

REML analysis was run for the estimation of genetic, phenotypic and environmental correlations. The correlations between various growth traits are presented in the Table 2. The terminology adopted for the discussion of the magnitude of various types of correlations (absolute values) was low=0.00 to 0.25, moderate=0.26 to 0.50, high=0.51 to 0.75 and very high=0.76 to 1.0. The estimates of genetic correlations between 6MW and 9MW were 0.71 and between 6MW and YW were 0.64. A high and positive genetic correlation between the traits under discussion was reported by Rashidi et al.[7] in Markhoz goats (0.79 and 0.62), Thiruvenkadan et al.,[15] in Tellicherry goats (0.640±0.056 and 0.887±0.141), High estimates of genetic correlations between six and nine month weight and between six month weight and yearling weight also reflect that there is a strong and positive genetic relationship between these traits. Selection for higher weight at six months in Teddy goat breed will result in higher weight at nine months and yearling weight as a correlated response as the traits seem to be under the strong effect of same genes. The positive and high estimates of genetic correlation are indicative of strong bond between the traits and improvement in one trait will lead to betterment of other trait to a greater extent as a correlated response.

Table 2 Estimates of genetic correlations (above diagonal) and phenotypic and environmental correlations (below the diagonal with environmental correlations in parentheses) for different growth traits in teddy goats

Trait	6WT	9WT	12WT	ADG1	ADG2	ADG3
6WT	-	0.71	0.64	0.97	0.71	0.61
9WT	0.27	-	0.79	0.72	0.96	0.76
	-0.25					
12WT	0.21	0.23	-	0.65	0.77	0.97
	-0.19	-0.21				
ADG1	0.31	0.81	0.1	-	0.71	0.63
	-0.29	-0.79	-0.08			
ADG2	0.31	0.81	0.1	0.97	-	0.75
	-0.28	-0.78	-0.09	-0.95		
ADG3	0.03	0.13	0.74	0.01	0.02	-
	-0.02	-0.11	-0.72	-0.01	-0.01	

6WT, 6month weight; 9WT, 9month weight; ADG1, post-weaning daily gain at six months; ADG2, post-weaning daily gain at nine months; ADG3, post-weaning daily gain at 12months

Estimation of breeding values and genetic trends

The estimates of breeding values in different traits are presented in Table 3, which were not in line with the findings of Shafiq & Sharif,[21] who reported that the estimated breeding values on the basis of post--weaning growth rates ranged from 5.2 to 11.7g, in Teddy goats and in the elite flock of Beetal goats it ranged from 35.96 to 63.29g, respectively in the two breeds. Hyder[33,34] reported estimated breeding values (EBV's) in Teddy goats. The EBV's on the basis of pre-weaning daily gain ranged from +32.82 to -35.02g. The overall phenotypic and genetic trends over the years for pre-weaning daily gains were slightly negative but close to zero. The average yearling weight of the Teddy

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goats was 19.8±0.65kg and phenotypic trend in yearling weights was negative.[32] The genetic and phenotypic trends for birth and weaning weight showed an increased trend in Teddy goats in the present study, whereas the genetic and phenotypic trends for 6MWand nine months fluctuated with the decreasing trend shown in the last 6 years of study from 2003 to 2006, however during the year 2007 increasing trend was observed in 6MWmonths.

Table 3 Estimated breeding values (EBV's) for different growth traits

Trait	EBVs Bucks	EBVs Does	EBVs overall
6WT(kg)	-0.24 to 0.09	-0.27 to 0.11	-0.27 to 0.11
9WT(kg)	-0.08 to 0.09	-0.07 to 0.09	-0.07 to 0.09
YWT(kg)	-0.12 to 0.16	-0.9 to 0.18	-0.12 to 0.18
ADG1(gms)	-0.71 to 1.27	-0.74 to 0.92	-0.74 to 1.27
ADG2(gms)	-0.30 to 0.57	-0.32 to 0.43	-0.32 to 0.57
ADG3(gms)	-1.08 to 1.57	-0.93 to 1.51	-1.08 to 1.57

The genetic trend for yearling weight did not show any specific trend and kept fluctuating with a dip in the last few years of the study period. Ali & Khan[22] reported that overall genetic trend for birth weight was static and they reported that estimated breeding values ranged from -0.61 to 0.60kg for bucks and -0.67 to 0.65kg for does, which were not in accordance with the finding of the present study.[22] The genetic and phenotypic trend lines for six month, nine month and yearling weights followed the same pattern with no specific trend being observed for the traits. The genetic trends remained oscillating around the x-axis for all the traits which was indicative of no net genetic gain, however in nine month and yearling weight during a particular time period from 1995 to 2000 some genetic gain had been achieved with EBV's for those 5-6years being on higher side for both these traits, but the trends dipped down below zero for both the traits after the year 2000.

The phenotypic trend lines for six and nine month weight remained static around zero, however in case of yearling weight the phenotypic trend showed an upward trend during the last few years of the study. This was indicative of absence of any directional selection for these traits. Ali & Khan[22] also reported that genetic trend for yearling weight was not different from zero in Beetal goats.[22] The genetic trend for pre-weaning daily gain however showed an upward trend particularly from 1994-2008. The phenotypic trend however, remained oscillating around x-axis with static trend being observed for the trait. The genetic trends for post-weaning daily gain at six, nine and twelve months of age showed almost the same pattern as was observed in weight at six, nine and twelve months of age.

Conclusion

Low to medium heritability was recorded in the growth traits, which offers scope for genetic selection. Selection of animals to be the parents of future flock must be based on EBVs of growth traits. The genetic trends for growth traits indicated that the breeding programme in all the three flocks under study has not proved efficient. It also pointed out that the selection of the animals has not been practiced in a proper direction and random mating to some extent has been practiced.

There can be many possible reasons

A. The selection being carried on type and conformation, which becomes destructive when it is centered without fixing standards of production, where in the animals above the average in real usefulness, have been discarded because they did not conform to breed type in matters which were of little or no economic value.

B. Another possible reason could be the genetic difference among the individuals which determines the rate of genetic improvement that can be accomplished through selection. With low estimates of heritability in some traits the anticipated improvement in those traits can be achieved more through altering the environment rather than selection.

C. The culling of animals may have not been carried out according to the recommendation as mostly it is a practice at livestock farms in this part to cull those animals which are sick, unfit for breeding or repeaters and seldom culling is carried out on the basis of low production. The possible use of ineffective selection could be unavailability of efficient techniques for the evaluation of animals and incorrect performance recording etc. It is therefore, necessary to correct all these discrepancies by taking corrective measures.

Acknowledgements

None.

Conflict of interest

Author declares that there is no conflict of interest.

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Citation: Kuthu ZH, Javed K, Ahmad N, et al. Genetic evaluation of post-weaning growth traits in teddy goats. *J Dairy Vet Anim Res.* 2015;2(2):66–71. DOI: 10.15406/jdvar.2015.02.00032