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Genetics of Growth Traits in Sheep: A Review

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Abstract: **There is a shift in objective of sheep farming from wool to mutton traits. A variety of sheep development programmes and research efforts for improving growth traits in India have been applied. Different breeds of sheep are being improved through selection, crossbreeding and inter-se mating. Genetic parameters for various growth traits of sheep have been reviewed. Least squares means and standard errors of estimates, heritability, genetic and phenotypic correlations among various growth traits are presented. Genetic and phenotypic correlations between the different growth traits were very sparse. More accurate analysis of genetic parameters and in particular correlations between different growth traits are required for accurate genetic evaluation and development of breeding objectives. Growth characteristics of indigenous and crossbred sheep evolved in different environmental conditions of country are reviewed.**

Keywords: **Correlation, Genetic parameters, Growth traits, Heritability.**

1. INTRODUCTION

Sheep is one of the important species of livestock in India contributing greatly to the agrarian economy, especially in the livelihood of a large proportion of small and marginal farmers and landless labourers. The sheep population in India is estimated to be about 65.07 million with second ranking in the world (BAHS, 2014). There are 40 descript breeds of sheep distributed in various agro-climatic zones of the country (NBAGR, 2015). A cross breeding of indigenous sheep with exotic breeds has been in practice since long to bring about the improvement in both wool and mutton production. Such attempts have been resulted in the evolution of some superior breeds, *viz*., Hissardale, Kashmir Merino, Bharat Merino, etc.

The growth rate is an economic trait of interest in domestic animals as growth of the lambs is a reflection of the adaptability and economic viability of the animal and hence may be used as criteria for the selection among breeds and the individual within breeds (Singh *et al*., 2006). Fast growth rate ultimately determines their meat producing capability up to market age. The study of body weights also helps or even guides the breeders to determine the optimum managemental practices so as to maintain the gain at an optimum level. Therefore an effort is being made in this article to compile the research efforts for genetic improvement of growth traits of various sheep breeds.

2. GROWTH PERFORMANCE IN DIFFERENT BREEDS

Growth traits are good indicators of adaptability of an animal to the existing environmental conditions and essential for production, reproduction and survivability. Fast growth rate ultimately determines their meat producing capability upto marketing age hence used as a criteria for selection. They are largely affected by both genetic and non-genetic factors.

A. Birth weight (BW):

Birth weight is the earliest available trait. Lambs with higher birth weights are expected to grow faster in life and it is influenced by various non-genetic factors. Birth weight of different breeds of sheep as reported in literature are presented in Table 1. Least squares means varies among breeds and ranged from 1.82±0.03 kg in Garole x Malpura (Gowane *et al.*, 2011) to 3.65±0.06 kg in Bharat Merino x Bannur (Mandya) crossbreds (Mallick *et al.*, 2015).

B. Weaning weight (WW):

Weaning weight is highly correlated with the mothering ability (milk yield and maternal instinct to care) of the ewe as the lamb meets most of its requirement through suckling and therefore the differences in weaning weight are essentially the reflections of mothering ability as well as inherent difference in growth. The age at weaning though varies from flock to flock, but in Indian flock, lambs are generally weaned at the age of three months.

The least squares mean of weaning weights reported by various workers in different breeds of sheep are presented in Table 1. It varied from 9.40±0.01 kg in Madras Red sheep (Devendran *et al.*, 2014) to 18.54±0.44 kg in Bharat Merino x Bannur (Mandya) crossbred (Mallick *et al.*, 2015).

C. Six month body weight (SMW):

The economy of sheep rearing mainly depends on six month body weight as this is the age at which the animals are sold for meat purpose.

The least squares mean of six month body weights reported by various workers in different breeds of sheep. It varied from 13.28±0.09 kg in crossbred sheep (Singh *et al* 2006) to 28.60±0.89 in Bharat Merino x Bannur/Mandya (Mallick *et al.*, 2015) and the results are presented in Table 1.

D. One year body weight (YBW):

There was very scanty information available on one year body weight. The overall least squares mean for this trait varied from 18.96±0.20 kg in crossbred sheep (Singh *et al.*, 2006) to 43.72±1.13 kg in Bharat Merino x Bannur (Mandya) (Mallick *et al.*, 2015).

The wide range of variability in growth traits among different breeds has been observed. However for improvement in these traits, it is essential to study intrabreed variability by estimating genetic parameters.

3. NON GENETIC FACTORS AFFECTINF GROWTH TRAITS

A. Effect of non genetic factors on birth weight:

Differences due to years arise mainly due to varying climatic conditions affecting the availability of pastures to the ewes carrying lambs as well as effect of these factors directly on the well being of ewes and lambs. The significant effect of year of birth and sex on birth weight was reported by Nehra *et al.* (2006) in Marwari sheep and Singh *et al.* (2006) in crossbred sheep. The significant effect of year was also reported by Kushwaha *et al.* (2010) in chokla sheep, Balasubramanyam *et al.* (2012) and Ganesan *et al.* (2013) in Madras Red sheep. However non significant effect of year on birth weight was reported by Mishra *et al.* (2008), Gowane *et al.* (2011) and Das *et al.* (2014). Males lambs were heavier than female at birth as reported by Nehra *et al.* (2006) and Singh *et al.* (2006) in crossbred sheep. The significant effect of sex on birth weight has also been reported by Waghmode *et al.* (2008), Prince *et al.* (2010), Chikurdekar *et al.* (2012), Momoh *et al.* (2013), Singh *et al.* (2013), Vivekanand *et al*. (2014) and Mane *et al.* (2014) in different breeds of sheep. Effect of dam's weight at lambing has been widely studied. Significant effect of dam's weight at lambing on birth weight has been observed by Dey (2004), Nehra *et al.* (2006), Mishra *et al.* (2008) and Singh *et al.* (2013). Prince *et al.* (2010) reported that heavier dams gave birth to heavier lambs because of better nutrition and more uterine space provided by them for developing foetus.

B. Effect of non genetic factors on weaning weight:

Significant effect of year of birth, sex of lamb and dam's weight at lambing on weaning weight was observed by Dangi *et al.* (2006), Nehra *et al.* (2006), Reddy *et al.* (2009), Baneh *et al.* (2010), Ganai *et al.* (2010), Balasubramanyam *et al.* (2012), Albial *et al.* (2014), Devendran *et al.* (2014) and Nirban *et al.* (2015) in different sheep breeds. Significant effect of year was also reported by Mohammadi *et al.* (2010). However non significant effect of year of birth on weaning weight was observed by Das *et al.* (2014) in Kashmir Merino sheep. Significant effect of sex on weaning weight has also been reported by Singh *et al* (2006), Balasubramanyam *et al.* (2010), Baneh *et al.* (2010), Ganai *et al.* (2010), Mohammadi *et al.* (2010) and Mane *et al.* (2014). Significant effect of dam's weight at lambing on weaning weight was reported by

Mishra *et al.* (2008), Chopra *et al.* (2010) and Singh *et al.* (2013), Devendran *et al.* (2014) and reported that weaning weight was significantly affected by dam's weight at lambing in Marwari sheep.

C. Effect of non genetic factors on six month body weight:

The significant effect of year of birth, sex of lamb and dam's weight at lambing on six month body weight was reported by Dangi *et al.* (2006), Nehra *et al.* (2006), Reddy *et al.* (2009), Baneh *et al.* (2010), Albial *et al.* (2014), Devendran *et al.* (2014), Hussain *et al.* (2014), Nirban *et al.* (2015) in different breeds of sheep. The significant effect of year of birth on this trait was also reported by Balasubramanyam *et al.* (2012). Significant effect of sex on six month body weight has been reported by Sahani *et al.* (2002), Singh *et al.* (2006), Balasubramanyam *et al.* (2010) and Mane *et al.* (2014). Significant effect of dam'weight at lambing on six month body weight was also observed by Mishra *et al.* (2008) and Chopra *et al.* (2010).

D. Effect of non genetic factors on one year body weight:

Nehra *et al.* (2006), Reddy *et al.* (2009), Ganai *et al.* (2010), Hussain *et al.* (2014), Mane *et al.* (2014), Nirban *et al.* (2015) found that one year body weight in different breeds of sheep has been significantly influenced by year of birth, sex of lamb and dam's weight at lambing. The significant effect of birth year on one year body weight was also reported by Balasubramanyam *et al.* (2012) in Madras Red sheep. Significant effect of sex on one year body weight has also been repoted by Sahani *et al.* (2002), Singh *et al.* (2006), Balasubramanyam *et al.* (2010), however Prince *et al.* (2010) observed non significant effect of dam's weight on one year body weight.

4. GENETIC AND PHENOTYPIC PARAMETERS

The knowledge of precise estimates of genetic and phenotypic parameters of performance traits is essential for developing suitable selection strategies for bringing about genetic improvement in these traits.

HERITABILITY OF GROWTH TRAITS:

Heritability estimates are useful for construction of selection indices, prediction of genetic response to selection and for deciding how much one can rely upon individual's own phenotype for selection. Hence, accurate estimates of heritability for different economic traits are indispensable in animal breeding programmes. Estimates of heritability for growth traits in different breeds of sheep have been summarized in Table 2 and 3, respectively.

The heritability estimates of growth traits in different breeds of sheep were estimated as moderate to high ranging from 0.22 to 0.65 (Table 3). However, Hussain *et al.*, (2014) reported very low estimates of heritability for six month body weight, yearly body weight in Thali sheep which may be due to sampling error. Moderate to high estimates of heritability of growth traits clearly pointed found the availability of genetic variability and scope for further improvement in growth performance of these breeds through selection.

GENETIC AND PHENOTYPIC CORRELATIONS:

Genetic correlations between two traits may arise from pleiotropic action of genes and linkage. The extent and direction of genetic correlations are essential to evaluate direct and correlated responses and net genetic gain, when simultaneous selection for several traits is practiced. The estimates of genetic and phenotypic correlations among various traits as reported by different workers are presented in Table 3.

The birth weight has high genetic correlation with WW, SMW and YBW as studied by Gowane *et al.* (2011) in Garole×Malpura and Ganeshan *et al.* (2013) in Madras Red sheep. This high genetic correlation of birth weight with other body weights at later ages indicates the scope for early selection of lambs for faster improvement in growth. Weianing weight is also having high phenotypic & genetic correlations with SMW & YBW as reported by Singh *e al.* (2006) and Gowane *et al.* (2011) in crossbred and Garole×Malpura sheep, respectively. They also observed high phenotypic and genetic correlations between SMW and YBW in these breeds. The high & positive correlations between growth traits at different stages indicates that such type of correlations can be utilized in selection programmes for early selection of lambs to improve lamb weight at market age.

5. CONCLUSION

The present review appraised the growth performance of different sheep breeds. The wide range of variation in growth traits of different sheep breeds. The moderately to high heritability of growth traits indicated the presence of genetic variability among breeds and there is wide scope for improvement of growth performance in these breeds. Favourable and high genetic correlations among growth traits are useful in selection programmes for early selection of lambs to improve market weight of lambs.

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APPENDIX - A

Table 1 Mean (±S.E.) of various growth traits in different breeds/crosses of sheep

Breed/cross	BW (kg)	WW (kg)	SMW (kg)	YBW (kg)	References
Synthetic sheep (1118)	3.25±0.17	10.56±0.07	13.36±0.07	-	Sehrawat (2005)
Crossbred sheep	-	10.36±0.21	13.41±0.27	-	Dangi *et al.* (2006)
Crossbred sheep	3.35±0.01	10.79±0.07	13.28±0.09	18.96±0.20	Singh *et al.* (2006)
Marwari (631)	2.77±0.04	11.78±0.20	16.45±0.27	20.70±0.31	Nehra *et al.* (2006)
Garole × Malpura	1.94±0.04	9.84±0.26	14.48±0.39	20.42±0.79	Mishra *et al.* (2008)
Madgyal (213)	3.08±0.022	18.16±0.136	23.94±0.190	31.00±0.226	Waghmode *et al.* (2008)
Nellore (250)	2.88	13.39	17.52	24.67	Reddy *et al.* (2009)
Chokla (1810)	2.73±0.04	12.74±0.22	16.71±0.26	21.81±0.35	Khushwaha *et al.* (2010)
Avikalin	2.95±0.02	14.48±0.10	20.02±0.14	25.78±0.19	Prince *et al.* (2010)
Garole × Malpura (1083)	1.82±0.03	9.44±0.18	14.00±0.24	19.32±0.35	Gowane *et al.* (2011)
Madras Red (5491)	2.76 ±0.01	9.90±0.06	14.53±0.05	21.05±0.09	Balasubramanyam *et al.* (2012)
Deccani (1498)	2.87±0.01	13.86±0.10	18.02±0.12	23.94±0.18	Chikurdekar *et al.* (2012)
Madras Red (1424)	2.687± 0.019	10.548± .093	14.943± 0.125	20.369± 0.202	Ganesan *et al.* (2013)
Balami and Uda (595)	3.34±0.03	13.52±0.07	20.29±0.09	32.15±0.18	Momoh *et al.* (2013)
Madras Red (403)	2.70±0.01	9.40±0.01	14.80±0.02	20.80±0.02	Devendran *et al.* (2014)
Magra (2309)	2.98±0.02	14.54±0.11	22.14±0.17	26.11±0.18	Vivekanand *et al.* (2014)
Marwari (4201)	3.10±0.01	15.01±0.11	20.91±0.15	28.00±0.16	Nirban *et al.* (2015)
Bharat Merino × Bannur (126)	3.65±0.06	18.54±0.44	28.60±0.89	43.72±1.13	Mallick *et al.* (2015)

Figure within parenthesis are the number of observation

Table 2. Heritability estimates (±S.E.) of various growth traits in different breeds/crosses of sheep

Breed/Cross	BW	WW	SMW	YBW	References
Ghezel	0.24	0.29	0.37	-	Baneh *et al.* (2010)
Garole×Malpura	0.30±0.11	0.22±0.09	0.23±0.10	0.30±0.11	Gowane *et al.* (2011)
Madras Red	0.258±0.138	0.508±0.160	0.516±0.166	0.651±0.190	Ganeshan *et al.* (2013)
Thalli	-	-	0.07±0.02	0.07±0.02	Hussain *et al.* (2014)

Figure within parenthesis are the number of observations

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Table 3. Genetic and phenotypic correlations along with standard errors among various economic traits in different breeds/crosses of sheep

Breed /cross	Trait	Genetic correlation	Phenotypic correlation	References
Correlation of birth weight with other traits				
Garole×Malpura	WW	0.75±0.17	0.47±0.02	Gowane *et al.* (2011)
Madras Red	-do-	-0.03787± 0.36598	-	Ganeshan *et al.* (2013)
Balami and Uda	-do-	-	0.28	Momoh *et al.* (2013)
Garole×Malpura	SMW	0.52±0.22	0.54±0.02	Gowane *et al.* (2011)
Madras Red	-do-	0.17610± 0.50488	-	Ganeshan *et al.* (2013)
Balami and Uda	-do-	-	0.27	Momoh *et al.* (2013)
Garole×Malpura	YBW	0.57±0.21	0.43±0.02	Gowane *et al.* (2011)
Balami and Uda	-do-	-	0.33	Momoh *et al.* (2013)
Correlation of weaning weight with other traits				
Crossbred	SMW	0.30±0.299	0.76±0.02	Singh *et al.* (2006)
Garole×Malpura	-do-	0.96±0.07	0.79±0.01	Gowane *et al.* (2011)
Garole×Malpura	YBW	0.93±0.09	0.71±0.02	Gowane *et al.* (2011)
Crossbred	-do-	0.26±0.03	-0.30±0.28	Singh *et al.* (2006)
Correlation of six month body weight with other traits				
Crossbred	YBW	0.53±0.17	0.54±0.02	Singh *et al.* (2006)
Garole×Malpura	-do-	0.95±0.06	0.80±0.02	Gowane *et al.* (2011)