

**MORPHOMETRIC AND PRODUCTION STUDY ON UAS BREED
OF SHEEP OF KARNATAKA**



THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

**Master of Science (Agriculture)
in
Animal Husbandry and Dairying
(Livestock Production and Management)**

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Dear Sir,

I have great pleasure in forwarding the thesis entitled **"Morphometric and Production Study on UAS Breed of Sheep of Karnataka."** submitted by **Mr. Basavaraja Guptha H T**, I.D. No. 16AHD03, in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture)** in **Animal Husbandry & Dairying (Livestock Production and Management)**, Institute of Agricultural Science, Banaras Hindu University, Varanasi (U.P.).

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By
Mr. Basavaraja Guptha H. T.

Thesis submitted in partial fulfillment of the requirements for the degree of

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in
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(Livestock Production Management)

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Affectionately Dedicated
to
**My Motherland Bharathmaatha,
Evercaring Parents
And Beloved Friends (BARR), V**

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Date:

Place: Varanasi

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I. INTRODUCTION

India is a developing country where Animal Husbandry and livestock plays an important role in improving rural economy especially for the landless labours, small and marginal farmers.

Sheep is one of the important species of livestock contributing to the livelihood of poor farmers in areas, especially in arid and semi arid region, where agriculture and dairy farming are not economical. Sheep are well adapted to area where soils are infertile/less fertile, rains are uncertain, ground water is not fit for agriculture, harsh climate and poor vegetation. Sheep is a gregarious animal, serves as insurance during the crop failure and during monsoon failure. Sheep husbandry is an important subsidiary and complimentary occupation in mixed / integrated farming. They can thrive in all agro-climatic regions except high rainfall areas and because of its close grazing habit they can thrive in low set sparse vegetation, where other livestock cannot thrive. Sheep does not require any expensive investment for buildings equipments, and hence, well suited for marginal and small farmers.

Sheep milk is extremely high in fat and conjugated linoleic acid (CLA) compared to other milk producing species. There is also a large amount of solids present in the sheep milk. This makes sheep milk an excellent choice for making cheese and it produces higher yields of cheese compared to other milk producing species.

The demand for meat and meat products is ever growing, owing to the rise of per capita income in developing countries. Among the various livestock products exported from India, more than 70 per cent is contributed by meat and meat products. Sheep is one of the important species of livestock contributing to meat production and mutton accounts for about five per cent of total meat produced. Sheep contribution to the national gross domestic production is substantial and important. They are integral and indispensable component of agriculture in India.

It is reported that about 56%of the rural population owns livestock, of which major share is occupied by the small ruminants only. Sheep farming is still in the hands of traditional shepherd community or economically weaker sections that are following traditional extensive system of rearing (Rajanna *et al.*, 2012).

Sheep and goats are the only domesticated species which can utilize wastelands, stubbles of cultivated crops, tree topping, farm wastes and weeds from the field to convert them into meat, manure, wool and skin. Sheep manure is having good potential to provide nutrients like N, P, K and micro-nutrients, sheep faeces + urine contains N,P,K in the ratio of 8.3:1.0:9.0 respectively, nitrogen here is slow releasing type which is need of the hour.

The Indian sheep are derived both from Urial and Argali stock; they are thin tailed, medium to coarse wool type in north temperate and north western regions and hairy type in southern peninsular and eastern regions. Since agro - climatic conditions of India are varied; the breeds developed under these conditions also vary in their morphology, genetic makeup, adaption, feed and fodder utilization, reproduction, growth and production characters.

Karnataka is one of the states of India having 9.58 million sheep population out of 65.7 million sheep in India secured second rank (19th livestock census, India, 2012) shows the sheep adoption to Karnataka tropical monsoon type climate and Karnataka hosts five well adopted indigenous sheep breeds including Deccani breed viz., Bellary, Kenguri, Hassan, and Mandya (Yadav *et al.*, 2013) Mouli and Yalaga sheep are under progress of characterization and registration of breeds from Karnataka. South India being tropical area most of Sheep breeds are of meat purpose and not for wool purpose. They produce rough carpet quality wool which is mainly utilized for making rough woollen carpets [Kambali].

Sheep genetic resource of India are represented by 42 well-defined breeds and sizeable non-descript populations. Sheep breeds in India today are mainly the resultant of two factors. First one due to long-term continuous natural selection for adoption to agro-ecology of their habitat and second is due to Man-made selection to meet social and economic requirements of the society. Among the two UAS breed of sheep fall under second category *i.e.* Man made selection to meet social and economic requirements.

The UAS breed of sheep was evolved by triple crossing method at main campus of University of Agricultural sciences, Dharwad, where Deccani sheep were maintained at sheep unit of Dharwad, later Bannur (Mandya) Rams were introduced in the flock and

resultant stock was subsequently crossed with Southdown rams. This was followed by closed flock mating. Hence, UAS breed of sheep has genetic composition of 25% Deccani, 25% Bannur and 50% Southdown. During breed development horned animals were culled. Further sheep were selected for creamy white wool, so those with off-coloured wool were culled and some of the ram lambs born with uni- or –bilateral cryptorchid condition were also culled. The flock was maintained exclusively on grazing at Dharwad campus where it was developed, this breed was released officially for breeding during 1985, later the sheep was taken to Hanumanamatti, Bidar, Bengaluru campuses for multiplication.

The UAS breed of sheep is a short statured animal with long body and cream coloured carpet quality wool, both the sexes are polled with slight Roman nose, these animals can produce 500 gm of carpet quality creamy white wool. The meat is tender and juicy and has a pleasant flavour.

The phenotype of the breed is result of the genetic constitution and environment in which they perform. Another major reason is managerial practices and the breeding practices of the farm. The present study was expected to give direction for breeding as well as managerial practices to be followed in UAS breed of sheep. The morphological studies in this breed are very scarce. In order to determine the morphological characters of UAS breed of sheep, the study was carried out at Dharwad and Hanumanamatti farms of UAS Dharwad with the following objectives.

Objectives of the study:

- To study the flock size, lambing and mortality in UAS sheep on the farms.
- To Study the growth performance of lambs.
- To Study the morphological characters of UAS breed of sheep.
- To develop prediction equations for estimating the body weight of lamb and adults UAS breed of Sheep.

II. REVIEW OF LITERATURE

In order to conduct any research, it is always necessary to look back into history and to find out what have been the findings of other research workers in the past. This would give a definite direction of the research to be conducted. Hence, an attempt to review the literature according to the objectives of the present study has been made and presented in this chapter.

2.1 Housing

Jain *et al.* (2005a) reported that bigger flocks of Bellary sheep are maintained in the open field having a low boundary and a small thatched shed just sufficient for one or two persons. While Hassan sheep are housed at night in a fenced enclosure with a shed in it, in most cases, generally the sheep house is either part of the owners dwelling or adjacent to it (Jain *et al.*, 2006b).

Arora *et al.* (2007) reported that in Jaisalmeri sheep housing for adult animals is mostly of open type, while in Ganjam sheep, animals were kept in open or thatched houses (during rainy season) nearby the residence (Nayak *et al.*, 2008).

As reported by Jain *et al.* (2006 a), in case of Kenguri sheep, fence is prepared either from bushes or other locally available material or from wires whereas, shed is thatched with tree branches and crop byproducts.

Dixit *et al.* (2005) reported that the non-migratory Rampur Bushair sheep were kept in closed houses (Khud, duar) in winter and in open during summer. The migratory sheep took shelter in the forest area under trees or carved stones.

Devendran *et al.* (2009) reported that no housing is provided for migratory flocks of Coimbatore sheep. The sheep are penned in the open harvested fields during nights and fenced with nylon nets of about four to five feet height supported by iron rods. In stationary flocks, housing is of open type with the side protection made up of wooden reapers or bamboos.

Chandran *et al.* (2009) reported that 68% of half open sheds and 32% of open type were provided for Vembur sheep. Lambs were kept in koodu, a round lamb hut during day time and released into the flock at night.

Housing pattern of Yalaga sheep consisted of 92.86 % of open type fenced and 7.14% of fenced enclosure with a thatched roof, which were located at the outskirts of villages in a cluster form as reported by Dayanand (2013). The fence is prepared from thorny bushes or iron wires. The lambs were kept in the fences during the day time and were released at night.

Shashikant (2014) reported that no housing is provided for the migratory Mouli flocks. The sheep are penned in harvested fields during nights and fenced with nylon nets of about 4-5 ft high supported with iron rods. Housing pattern of stationary Mouli sheep consisted of 91.01% of open type fence and 8.99 % of fence enclosed with a thatched roof, which were located in a cluster form on the outskirts of the villages. The fence is prepared from thorny bushes or iron wires. The lambs were kept in the fenced enclosure during day time and were released at night to feed on their mothers.

2.2 Feeding

Vembur breed of sheep were studied by Chandran *et al.* (2009) and reported that the main sources of feed were grasses stubbles, herbs and tree leaves. Most of rams in addition to grazing were fed with grains of jowar (*Sorghum*) and wheat (*Triticum vulgare*). Lambs were maintained on ewes milk up to one month and then they were fed with cooked grains of Bajra (*Pennisetum typhoides*) and leaves of sesbania (*Sesbania glandiflora*), Neem (*Azadirachta indica*) and castor (*Ricinus communis*) and watering is done two or three times a day.

Devendran *et al.* (2009) made a study on Coimbatore sheep and reported that sheep solely depended on grazing and they were allowed to graze extensively up to a distance of 5-8 km for 5-8 hrs a day in the harvested fields, barren and un-cultivable lands of forest areas and road sides. The main source of grazing was grasses, stubbles, weeds and herbs. No tree fodder was fed to the sheep even during the period of scarcity. Lambs of 15 days old were also sent for grazing along with adults.

Bellary, Hassan, Mandya and Kenguri breeds of sheep were subjected to extensive management system with little or no supplementary feeding (Yadav *et al.*, 2013). The animals were grazed on crop stubbles and low forage on barren land and road sides for 6-8 hours daily. For two to three times a day animals were taken to water.

Fodder like jowar (*Sorghum*), wheat (*Triticum vulgare*), ragi (*Eleusine coracana*), horsegram (*Macrotyloma uniflorum*), leaves of peepal (*Ficus religiosa*) and neem (*Azadirachta indica*) were given as supplementary feed during lean period to Mandya sheep. Stall feeding of small flocks is routinely carried by Mandya sheep rearers. During breeding season the Bellary sheep rearers provided supplementary feeding to the breeding rams.

Yalaga sheep cover daily 4 to 5 km for grazing from 9 am to 6 pm. The grazing area included uncultivated lands and river banks. Sometimes cultivated area after harvesting was also used for grazing. The supplementary feeding for lambs and rams was more common. Watering was done usually 2 to 3 times a day by source like rivers and ponds (Dayanand, 2013).

Shashikant (2014) reported that Mouli sheep were taken for grazing at about 9 am and return to the camp – site at sunset. The sheep graze on crop stubbles and low grade forage on barren land and roadsides, supplementary feeding is rare except for the breeding rams and for ram lambs. Watering was done 2 to 3 times a day and source of water was rivers and ponds.

2.3 Lambing rate of sheep breeds

Balasubramanyam (2012) recorded 85.6 % of lambing in Madras Red sheep whereas, Mishra et.al (2007) reported 89.67 % lambing in Malpura sheep and 106.66 % in Garole × Malpura breed.

2.4 Sex ratio in sheep flocks

The proportion of males born either dead or alive is sex ratio at birth and proportion of males present at weaning (approximately 150 Days of age) is sex ratio at weaning.

Govind Mohan *et al.* (2017) reported 49.98 % sex ratio in Malpura flocks, Reddy and Naidu (2007) made study on Nellore sheep and found 49.30 %, 45.85 % and 49.26 % in single lambing, twins lambing and overall flock respectively.

2.5 Mortality rate in different breeds of sheep

The proportion of number of animals died to that of number of animals exposed to risk is called mortality. High mortality rates reduce the efficiency and profitability of the unit. The mortality rates of different breeds at different age is listed in table 2.5.

Table 2.5: Mortality rate of different breeds of sheep

Breed	Pre-weaving	Post weaving	Male	Female	Overall	Reference
Avikalin	4.29 %		4.34 %	4.25 %		Gowane <i>et al.</i> (2017)
Chokla	5.17 %		5.38 %	4.96 %		
Malpura	4.07 %		4.33 %	3.80 %		
Muzaffarnagari	6.60 %	6.0 %	7.39 ± 1.08	2.71 ± 1.17	12.6 %	Ajoy <i>et al.</i> (2007)
Marwari	3.73 %	3.94 %				Lokesh Kumar (2016)
Corridale	12.0 %	3.8 %				Coop (2012)
Malpura					17.26 %	Govind Mohan <i>et al.</i> (2017)
Muzaffarnagari	2.33 %	2.18 %	1.05 %	1.05 %	5.04 %	Verma <i>et al.</i> (2014)

Yadav *et al.* (2016) studied on Sonadi sheep and reported mortality rate of 57.0 %, 15.7 % and 27.3 % in summer, winter and rainy season respectively.

Similarly Verma *et al.* (2014) reported 0.90 %, 1.66 % and 2.48 % mortality in Muzaffarnagari sheep during summer, winter and Rainy seasons respectively.

2.6 Growth rate in sheep

The growth rate of different breeds at different ages in sheep is listed below.

Table 2.6: Growth rate of different breeds of sheep

Sl. No.	Breed	0-3 mo.	3-6 mo.	6-9 mo.	9-12 mo.	6-12 mo.	References
1	Deccani	110	53	30	20		Jagtap <i>et al.</i> (1989)
2	Ganjam (M) Ganjam (F) Ganjam (O)	59 50 55	64.0 ± 10 54.0±0.0 59.0±0.0	35.0±1 27.0±1.0 31.0±1.0	22.0 ±1.0 19.0±1.0 20.0 ± 0.9		Mohanty and Mishra (1992)
3	Balangir	59.0 ± 0.9	44.0 ± 1.0	30.00±0.91	21.0 ± 0.9		Mohanty and Mishra (1992)
4	Nilagiri (M) Nilagiri (F) Nilagiri (O)	78.50 ± 1.37 72.50 ± 1.47 75.50 ± 1.14	52.20±1.31 42.20±1.31 47.20±1.10	40.30±1.51 32.70±1.28 36.50±1.16	28.0 ± 1.4 20.70±1.16 24.30±1.07		Pannerselvam (1993)
5	Mecheri (M) Mecheri (F)	84.20± 1.70 75.20 ± 1.50	55.30±1.60 46.50±2.10	42.10±1.20 33.00±1.60	32.4.0± 0.90 21.20±1.20		Jagatheesan <i>et al.</i> (2003)
6	Madras Red	90.38± 0.25	47.68±0.21	46.69 ± 0.75	32.76.0± 1.06		Balasubramanyan <i>et al.</i> (2012)
7	Chokla	91.00 ± 1.0	75.00± 1.9			32.00 ± 0.6	Prince <i>et al.</i> (2008)
8	Garole× Malpura	104.9 ± 1.27	63.12± 1.07				Mishra <i>et al.</i> (2009)
9	Sonadi	92	60	33	41		Tailor and Yadav (2009)
9	Magra	137.41 ± 0.83	84.09 ± 0.75			34.89±0.41	Narula <i>et al.</i> (2009)
10	Marwari	134.80 ± 2.14	66.47± 1.73	48.96±2.02	31.230± 2.25		Gohil (2010)
11	Marwari	133.50± 1.43	66.75± 1.03			38.67±1.17	Singh (2012)
12	Marwari	131.88 ± 1.09	66.07± 0.82			36.79±6.77	Nirban (2013)
13	Chokla (M) (F) (O)	114.19±1.33 105.75 ± 1.33 109.97 ± 1.24	78.84± 1.17 62.49 ± 1.10 70.67 ± 1.08			32.94±0.93 26.38± 0.93 29.66±8.79	Prakash (2016)

Table 2.6a: The average pre and post weaving growth rate of exotic breeds, cross breeds and synthetic sheep breeds

Sl. No.	Breed	Pre-weaving	Post-weaving	Reference
---------	-------	-------------	--------------	-----------

1	Rambouillet/Merino × Gaddi		70.80 ± 5.30	39.40±5.20	Singh and Prakash (1986)
2	Rambouillet × patanwadi		116.60 ± 3.02	28.04 ± 5.20	Singh (1986)
3	Nilgiri Synthetic	(M) (F) (O)	83.00 ± 1.00 77.00 ± 1.00 80.00 ± 1.00	53.00 ± 0 48.00 ± 0 50.00 ± 0	IY ue (1993)
4	Awassi	(M) (F) (O)	163.60 ± 2.70 152.10 ± 2.70 157.80 ± 2.10	56.10 ± 0 50.00 ± 0 53.00± 0	Alrawi <i>et al.</i> (1982)
5	Hissardale	(M) (F) (O)	138.00 ± 0 127.00 ± 0 135.00 ± 0.04	50.00 ± 0 42.00 ± 0 45.00± 0	Akhtar (1996)
6	Bharat Merino	(M) (F) (O)	139.00 ± 1.80 128.00 ± 1.80 133.00 ± 1.60	58.00 ± 0.9 45.00 ± 0.9 52.00± 0.9	Dixit <i>et al.</i> (2001)
7	Avikalin		127.50 ± 1.5	31.500± 0.9	Prince <i>et al.</i> (2010)
8	Harnali	(M) (F) (O)	102.10 ± 1.09 99.22 ± 1.01 100.66± 0.86	36.29 ± 0.52 33.84 ± 0.48 35.07± 0.39	Lalit <i>et al.</i> (2015)
	UAS Sheep		90.20 ± 0.12	66.80 ± 1.70 (3-6 months)	Basavaish <i>et al.</i> (1994)

Table 2.6b: Mean pre, post weaning growth rates of Indian sheep breeds

Sl. No.	Breed	Pre-weaving	Post-weaving	Reference
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1	Muzzafnagari	127.8 $\pm$ 3.3	49.40 $\pm$ 1.6	Mandal <i>et al.</i> (2003)
2	Madras Red	69.99 $\pm$ 0.23	44.56 $\pm$ 0.23	Balasubramanyam <i>et al.</i> (2010)
3	Madras Red	73.70 $\pm$ 0.14	42.39 $\pm$ 2	Devendran <i>et al.</i> (2010)
4	Nilgiri	79.76	36	Venkata Ramanan (2013)
5	Sandyno	85.15	38.92	Venkata Ramanan (2013)

Highest growth rate was observed in Awassi males was 163.60 $\pm$ 2.70 g/day at pre-weaning age, Magra sheep had 137.41 $\pm$ 0.83 g/day during birth to 3 months age. The reports says that Marwari sheep had 130-135 g/day growth up to 3 months and 66 g/day growth from 3 to 6 months age. Almost all sheep breeds shows that as age increases the growth rate decreases. Basavaiah *et al.* (1994) reported growth rate 90.20 $\pm$ 0.12 and 66.80 $\pm$ 1.70 g/day in UAS breed of sheep at the pre-weaning and post-weaning stage, respectively.

2.7 Body weight of lambs

The least squares means of body weight of lambs, weaners, hoggets, two teeth and four teeth adults were 8.76 $\pm$ 0.20, 14.89 $\pm$ 0.11, 22.91 $\pm$ 0.18, 27.81 $\pm$ 0.21 and 37.66 $\pm$ 0.17 kg, respectively (Arora, *et al* (2007) .

Table 2.7: Body weight (kg) of lambs

Sl.	Breed	Birth weight	Three month	Reference
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No.			weight	
1.	Mandya	2.2 $\pm$ 0.60	11.70 $\pm$ 0.80	Ravi <i>et al.</i> (1988)
2.	Mecheri	2.82 $\pm$ 0.01	10.09 $\pm$ 0.10	Karunanithi <i>et al.</i> (2005)
3.	Bellary	2.01	14.10	Jain <i>et al.</i> (2005 a)
4.	Marwari	2.77 $\pm$ 0.04	11.78 $\pm$ 0.20	Nehra and Singh (2006)
5.	Hassan	2.39	13.10	Jain <i>et al.</i> (2006 b)
6.	Coimbatore	2.40 $\pm$ 0.10	12.40 $\pm$ 0.40	Devendran <i>et al.</i> (2009)
7.	Madras Red	2.68 $\pm$ 0.01	9.64 $\pm$ 0.03	Sivakumatr <i>et al.</i> (2009)
8.	Malpura	3.00 $\pm$ 0.01	13.53 $\pm$ 0.07	Arora <i>et al.</i> (2010)
9.	Kenguri Male	2.99 $\pm$ 0.08		Appannavar <i>et al.</i> (2010)
	Female	2.79 $\pm$ 0.08		

Dayanand (2013) and Shashikant (2014) conducted a study on Yalaga and Mouli breed of sheep and reported the birth weight, weight at 1 month, weight at 2 months and weight at 3 months of lambs is presented in Table 2.7a.

Table 2.7a: Body weights of lambs up to three months (kg)

Sl. No	Breed	Age	Males	Females	Reference
1	Yalaga	Birth	3.28 $\pm$ 0.25	3.93 $\pm$ 0.26	Dayanand (2013)
		1 month	6.79 $\pm$ 0.28	6.70 $\pm$ 0.40	
		2 months	14.23 $\pm$ 0.40	12.93 $\pm$ 0.36	
		3 months	21.22 $\pm$ 0.29	19.50 $\pm$ 0.36	
2	Mouli	Birth	3.76 0.01	3.55 $\pm$ 0.01	Shashikant (2014)
		1 month	12.11 $\pm$ 0.02	11.58 $\pm$ 0.03	
		2 months	14.40 $\pm$ 0.08	13.94 $\pm$ 0.02	
		3 months	19.05 $\pm$ 0.15	16.76 $\pm$ 0.09	

The highest female lambs at birth was observed in Yalaga 3.93 $\pm$ 0.26 kg and in male was in Mouli 3.76 $\pm$ 0.01 kg at three months both male and females highest body weight was reported in Mouli sheep 21.22 $\pm$ 0.29 and 19.50 $\pm$ 0.36 kg, respectively.

2.8 Morphological characters

2.8.1 Body length

The body length (cm) of different breeds of sheep as reported, are presented in Table 2.8.1.

Devendran *et al.* (2009) reported that body length of Coimbatore sheep in two teeth, four teeth, six teeth and full mouth as 963.20 ± 0.60 , 65.90 ± 0.50 , 68.40 ± 0.70 and 68.20 ± 0.40 cm respectively in males and 59.50 ± 0.40 , 60.20 ± 0.30 , 61.60 ± 0.40 and 62.40 ± 0.40 cm, respectively in females.

Chandran *et al.* (2009) reported body length in males and females of Vembur sheep in two teeth, four teeth, six teeth and full mouth as 72.60 ± 0.70 , 77.80 ± 0.80 , 76.20 ± 1.00 and 76.70 ± 2.30 cm, respectively in males, 64.30 ± 0.30 , 66.70 ± 0.30 , 67.30 ± 0.20 and 68.70 ± 0.30 cm, respectively in females.

Among Yalaga sheep body length reported by Dayanand (2013) in two teeth, four teeth, six teeth and full mouth as 80.71 ± 0.95 , 86.79 ± 1.37 , 82.93 ± 0.91 and 85.40 ± 1.50 cm, respectively in males and 72.08 ± 0.52 , 73.44 ± 0.46 , 74.71 ± 0.40 and 74.47 ± 0.33 cm respectively in females.

Body length of Mouli sheep as reported by Shashikant (2014) in males and females at two teeth, four teeth, six teeth and full mouth were 83.46 ± 0.75 , 83.43 ± 1.15 , 90.34 ± 0.73 and 87.62 ± 0.56 cm, respectively in males and in females 75.92 ± 0.53 , 76.83 ± 0.43 , 80.15 ± 0.45 and 79.41 ± 0.29 cm, respectively.

Among the breeds reviewed Munjal sheep, Yalaga sheep and Mouli sheep breeds reported longer body length as compared to other breeds and shorter body length reported was Rampur Bushair with 52.56 ± 0.58 , 50.34 ± 0.71 cm in male and female, respectively.

Table 2.8.1 Body length (cm)

Sl. No.	Breed	Male	Female	Reference
1.	Munjal	82.76 $\pm$ 1.07	74.55 $\pm$ 0.80	Kushwaha <i>et al.</i> (1999)
2.	Jalauni	71.50 $\pm$ 1.30	63.20 $\pm$ 0.50	Sahana <i>et al.</i> (2003)
3.	Bellary	70.20 $\pm$ 0.38	65.60 $\pm$ 0.14	Jain <i>et al.</i> (2005 a)
4.	Mandya	68.30 $\pm$ 0.51	60.60 $\pm$ 0.17	Jain <i>et al.</i> (2005 b)
5.	Mecheri	70.90 $\pm$ 0.60	63.10 $\pm$ 0.50	Karunanithi <i>et al.</i> (2005)
6.	Rampur Bushair	52.56 $\pm$ 0.58	50.34 $\pm$ 0.71	Dixit <i>et al.</i> (2005)
7.	Kenguri	74.70 $\pm$ 0.45	67.30 $\pm$ 0.15	Jain <i>et al.</i> (2006 a)
8.	Hassan	64.30 $\pm$ 0.64	62.00 $\pm$ 0.21	Jain <i>et al.</i> (2006 b)
9.	Jaisalmeri	71.78 $\pm$ 0.35	67.17 $\pm$ 0.19	Arora <i>et al.</i> (2007)
10	Coimbatore	68.20 $\pm$ 0.40	62.40 $\pm$ 0.40	Devendran <i>et al.</i> (2009)
11.	Vembur	76.70 $\pm$ 2.30	68.70 $\pm$ 0.30	Chandran <i>et al.</i> (2009)
12.	Munjal	83.85 $\pm$ 0.85	75.60 $\pm$ 0.33	Yadav <i>et al.</i> (2011)
13	Ramnad White	72.30 $\pm$ 0.99	65.50 $\pm$ 0.30	Raja <i>et al.</i> (2012)
14	Yalaga	83.44 $\pm$ 0.68	74.11 $\pm$ 0.22	Dayanand (2013)
15	Mouli	86.50 $\pm$ 0.43	78.24 $\pm$ 0.53	Shashikant (2014)

2.8.2 Height at withers

The average height at withers of different sheep breeds as reported by various workers are presented in Table 2.8.2

The average height at withers of different sheep breeds at different teeth stage are presented in Table 2.8.2a

Among all the breeds reviewed in both the tables Yalaga and Mouli sheep reported higher height at withers and Mouli sheep was tallest. 87.85 $\pm$ 0.37 cm for males and 79.77 $\pm$ 0.17 cm for females. Rampur Bushair sheep were reported to have shorter height at withers (58.6 $\pm$ 0.30cm in male and 53.93 $\pm$ 0.45cm for females).

Table 2.8.2: Height at withers (cm)

Sl. No.	Breed	Male	Female	Reference
1.	Munjal	78.71 $\pm$ 1.01	68.73 $\pm$ 0.59	Kushwaha <i>et al.</i> (1999)
2.	Jalauni	71.90 $\pm$ 1.20	63.30 $\pm$ 0.40	Sahana <i>et al.</i> (2003)
3.	Bellary	74.50 $\pm$ 0.32	68.90 $\pm$ 0.13	Jain <i>et al.</i> (2005 a)
4.	Mandya	62.30 $\pm$ 0.60	54.60 $\pm$ 0.20	Jain <i>et al.</i> (2005 b)
5.	Mecheri	71.10 $\pm$ 0.50	65.70 $\pm$ 0.50	Karunanithi <i>et al.</i> (2005)
6.	Rampur Bushair	58.60 $\pm$ 0.30	53.93 $\pm$ 0.45	Dixit <i>et al.</i> (2005)
7.	Kenguri	81.50 $\pm$ 0.43	72.60 $\pm$ 0.14	Jain <i>et al.</i> (2006 a)
8.	Hassan	64.40 $\pm$ 0.61	60.80 $\pm$ 0.23	Jain <i>et al.</i> (2006 b)
9.	Jaisalmeri	71.65 $\pm$ 0.28	67.48 $\pm$ 0.15	Arora <i>et al.</i> (2007)
10.	Munjal	80.38 $\pm$ 0.69	73.24 $\pm$ 0.25	Yadav <i>et al.</i> (2011)
11	Ramnad White	81.80 $\pm$ 0.57	74.40 $\pm$ 0.20	Raja <i>et al.</i> (2012)
12	Yalaga	86.29 $\pm$ 0.49	76.40 $\pm$ 0.21	Dayanand (2013)
13	Mouli	87.35 $\pm$ 0.47	79.77 $\pm$ 0.17	Shashikant (2014)

Table 2.8.2a: Height at withers at different ages

Teeth	Coimbatore		Vembur		Yalaga		Mouli	
Stage	Male	Female	Male	Female	Male	Female	Male	Female
2 teeth	62.10 $\pm$ 0.50	59.20 $\pm$ 0.30	77.80 $\pm$ 0.80	72.00 $\pm$ 0.30	84.76 $\pm$ 0.68	75.13 $\pm$ 0.60	83.95 $\pm$ 0.64	77.82 $\pm$ 0.40
4 teeth	66.10 $\pm$ 0.50	60.13 $\pm$ 0.30	82.71 $\pm$ 0.80	74.50 $\pm$ 0.40	88.33 $\pm$ 0.99	76.11 $\pm$ 0.37	87.13 $\pm$ 1.04	79.08 $\pm$ 0.35
6 teeth	67.00 $\pm$ 0.60	60.90 $\pm$ 0.40	83.30 $\pm$ 0.70	75.60 $\pm$ 0.20	86.14 $\pm$ 0.85	77.27 $\pm$ 0.42	90.51 $\pm$ 0.66	81.22 $\pm$ 0.35
8 teeth	67.60 $\pm$ 0.40	60.90 $\pm$ 0.30	82.20 $\pm$ 1.10	73.30 $\pm$ 0.30	86.80 $\pm$ 1.28	76.24 $\pm$ 0.33	87.98 $\pm$ 0.46	80.43 $\pm$ 0.22
Reference	Devendran <i>et al.</i> (2009)		Chandran <i>et al.</i> (2009)		Dayanand (2013)		Shashikant (2014)	

2.8.3 Chest girth

The chest girth of different breeds of sheep reported is presented in Table 2.8.3.

Chest girth in males and females different breed of sheep at two teeth, fourth, six teeth and full mouth are presented in Table 2.8.3a.

Among all the breeds studied Munjal and Yalaga breed of sheep had higher chest girth compared to other breeds.

Table 2.8.3: Chest girth (cm)

Sl. No.	Breed	Male	Female	Reference
1.	Munjal	95.57 $\pm$ 1.51		Kushwaha <i>et al.</i> (1999)
2.	Bellary	82.50 $\pm$ 0.42	76.10 $\pm$ 0.17	Jain <i>et al.</i> (2005 a)
3.	Mandya	79.20 $\pm$ 0.73	69.60 $\pm$ 0.23	Jain <i>et al.</i> (2005 b)
4.	Mecheri	80.00 $\pm$ 0.60	71.00 $\pm$ 0.60	Karunanithi <i>et al.</i> (2005)
5.	Rampur Bushair	79.63 $\pm$ 0.49	75.99 $\pm$ 0.38	Dixit <i>et al.</i> (2005)
6.	Kenguri	89.40 $\pm$ 0.54	78.40 $\pm$ 0.20	Jain <i>et al.</i> (2006 a)
7.	Hassan	75.30 $\pm$ 0.61	72.00 $\pm$ 0.36	Jain <i>et al.</i> (2006 b)
8.	Jaisalmeri	83.94 $\pm$ 0.33	79.45 $\pm$ 0.17	Arora <i>et al.</i> (2007)
9.	Munjal	91.76 $\pm$ 0.73	83.78 $\pm$ 0.39	Yadav <i>et al.</i> (2011)
10.	Yalaga	92.32 $\pm$ 0.77	79.97 $\pm$ 0.33	Dayanand (2013)
11.	Mouli	87.62 $\pm$ 0.72	81.73 $\pm$ 0.25	Shashikant (2014)

Table 2.8.3a Chest girth at different ages (cm)

Teeth	Coimbatore		Vembur		Yalaga		Mouli	
Stage	Male	Female	Male	Female	Male	Female	Male	Female
2 teeth	71.90 ± 0.70	66.90 $\pm$ 0.50	79.80 $\pm$ 1.50	73.90 $\pm$ 0.40	88.06 ± 0.90	77.08 $\pm$ 0.40	82.53 ± 0.80	77.62 $\pm$ 0.40
4 teeth	76.30 ± 0.70	68.30 $\pm$ 0.40	85.90 $\pm$ 0.90	76.90 $\pm$ 0.30	95.96 ± 1.66	78.62 $\pm$ 0.40	88.26 ± 1.04	79.94 $\pm$ 0.47
6 teeth	77.50 ± 0.70	69.40 $\pm$ 0.40	90.00 $\pm$ 0.90	78.80 $\pm$ 0.20	95.07 ± 1.03	81.06 $\pm$ 0.48	91.45 ± 1.04	83.66 $\pm$ 0.47
8 teeth	78.40 ± 0.50	69.80 $\pm$ 0.40	89.40 $\pm$ 0.80	81.20 ± 0.30	94.20 ± 0.44	80.50 $\pm$ 0.30	90.38 ± 0.63	84.46 $\pm$ 0.30
Reference	Devendran <i>et al.</i> (2009)		Chandran <i>et al.</i> (2009)		Dayanand (2013)		Shashikant (2014)	

Table 2.8.4 Pouch girth

Sl. No.	Breed	Male	Female	Reference
1.	Kenguri	84.50 $\pm$ 0.79 (68-99)	76.90 $\pm$ 0.28 (56-93)	Jain <i>et al.</i> (2006)
2.	Yalaga	75.20 $\pm$ 0.51 (61-90)	85.40 $\pm$ 0.71 (71-101)	Jain <i>et al.</i> (2017b)
3.	Mouli	79.00 $\pm$ 0.97 (74-103)	86.20 $\pm$ 1.20 (66-104)	Jain <i>et al.</i> (2017a)

The pouch girth of male was highest in Kenguri 84.5 $\pm$ 0.79 and in female Mouli sheep recorded highest pouch girth of 86.20 $\pm$ 1.20 cm.

2.8.5 Flank width

The average flank width of adult males and females of Yalaga sheep reported by Dayanand (2013) were 18.41 $\pm$ 0.19 and 17.50 $\pm$ 0.08 cm, respectively.

Shashikant (2014) reported that the average flank width of adult males and females of Mouli breed of sheep were 19.45 $\pm$ 0.11 and 18.52 $\pm$ 0.06 cm, respectively.

2.8.6 Body weight

The adult male and female body weights of different breeds of sheep are presented in Table 2.8.6.

As per review Munjal and Mouli breeds were having higher body weight and Hassan breed had lowest body weight.

Arora *et al.* (2007) made a study in Jaisalmeri sheep and reported that the average weight of adult rams were 43.28 ± 0.30 kg and of ewes 32.05 ± 0.16 kg.

Yadav *et al.* (2013) conducted study and reported that the population variability showed Kenguri ewes were the largest and heaviest followed by Bellary, Hassan and Mandya, whereas, Kenguri rams were largest followed by Bellary, Mandya and Hassan. Overall sexual dimorphism (m/g) was 1.13 with Kenguri males being 47 per cent heavier than females.

Sreenivasu *et al.* (2003) reported that the body weight and measurements were significantly affected by mandals, grazing and management practices adopted by the farmers in Deccani sheep.

Table 2.8.6: Body weight (kg)

Sl. No.	Breed	Male	Female	Reference
1.	Munjal	65.93 ± 2.43	45.37 ± 0.99	Kushwaha <i>et al.</i> (1999)
2.	Madras Red	35.20 ± 0.32	23.12 ± 0.14	Raman <i>et al.</i> (2003)
3.	Bellary	42.80 ± 0.61	31.80 ± 0.22	Jain <i>et al.</i> (2005 a)
4.	Mandya	36.80 ± 1.08	26.70 ± 0.21	Jain <i>et al.</i> (2005 b)
5.	Rampur Bushair	34.70	26.00	Dixit <i>et al.</i> (2005)
6.	Kenguri	52.60 ± 0.86	35.90 ± 0.24	Jain <i>et al.</i> (2006 a)
7.	Hassan	32.80 ± 0.85	28.34 ± 0.34	Jain <i>et al.</i> (2006 b)
8.	Muzaffarnagri	50.20	39.60	Dinesh <i>et al.</i> (2006)
9.	Vembur	43.10	29.90	Chandran <i>et al.</i> (2009)
10.	Marwari	40.70 ± 1.13	30.10 ± 0.28	Yadav <i>et al.</i> (2009)
11.	Yalaga	54.78 ± 0.96	35.90 ± 0.24	Dayanand (2013)
12.	Mouli	54.54 ± 0.77	42.35 ± 0.30	Shashikant (2014)

2.9 Non-productive biometric traits and their means in sheep breeds

2.9a Face length

In adult Ganjam Nayak *et al.* (2008) reported that the face length in males was 23.51 ± 0.10 cm and in females 23.48 ± 0.06 cm with overall average of 23.49 ± 0.05 cm.

Face length of different breeds of southern Tamil Nadu given by Ravimuragan *et al.* (2012) is presented in Table 2.9a.

Face length reported for other sheep breeds at different stage of their growth are presented in Table 2.9a1

Mouli sheep had highest face length in both adult males and females.

Table 2.9a Face length (cm)

Sex	Chevadu	Katchaikaty	Kilakarsal	Ramnad White	Vembur	Pattanam
Male	18.20 ± 0.23	18.33 ± 0.66	18.50 ± 0.29	24.35 ± 0.74	20.75 ± 0.20	20.15 ± 0.70
Female	17.17 ± 0.17	16.86 ± 0.06	18.29 ± 0.12	18.52 ± 0.14	19.03 ± 0.16	20.05 ± 0.15

Table 2.9a1 Face length (cm) at different ages

Breed	Sex	2 Teeth	4 Teeth	6 Teeth	8 Teeth	Reference
Vembur	Male	24.00 ± 0.10	24.30 ± 0.30	23.70 ± 0.30	24.10 ± 0.80	Chandran <i>et al.</i> (2009)
	Female	20.01 ± 0.20	21.10 ± 0.20	22.20 ± 0.30	21.70 ± 0.30	
Yalaga	Male	25.35 ± 0.31	26.00 ± 0.34	25.71 ± 0.33	26.30 ± 0.43	Dayanand (2013)
	Female	23.08 ± 0.24	23.24 ± 0.11	23.27 ± 0.14	23.16 ± 0.10	
Mouli	Male	28.95 ± 0.31	29.78 ± 0.43	30.05 ± 0.40	30.74 ± 0.28	Shashikant (2014)
	Female	26.28 ± 0.18	27.09 ± 0.17	27.32 ± 0.19	27.48 ± 0.21	

2.9b Ear length

The ear length reported in different breeds of sheep by various workers is presented in Table 2.9b

The average ear length varied from 10.5 cm (Rampur Bashiar) to 20.81 cm in Mouli breed of sheep. Further, there was not much difference between male and female ear lengths.

Table 2.9b: Ear length (cm) of different sheep breeds

Sl. No.	Breed	Average Ear Length	Males	Females	Reference
1.	Bellary	13.20			Jain <i>et al.</i> (2005a)
2.	Mandya	13.00 $\pm$ 0.08			Jain <i>et al.</i> (2005 b)
3.	Rampur Bushair	10.15			Dixit <i>et al.</i> (2005)
4	Mecheri	14.60 $\pm$ 0.10			Karunanithi <i>et al.</i> (2005)
5	Kenguri		15.20 $\pm$ 0.14	15.30 $\pm$ 0.07	Jain <i>et al.</i> (2006a)
6.	Hassan	14.10 $\pm$ 0.09			Jain <i>et al.</i> (2006b)

2.9c Tail length

The studies reported different tail length of different breeds are presented in Table 2.9c.

Among the breeds reviewed average tail length of Mecheri sheep (8.10 $\pm$ 0.20 cm) was having shortest tail and Munjal breed had longest tail (44.85 $\pm$ 1.82 cm in males and 39.13 $\pm$ 6.86 cm in females).

Table 2.9c: Tail length (cm)

Sl. No.	Breed	Average Tail Length	Males	Females	Reference
1.	Munjal		44.85 $\pm$ 1.82	39.13 $\pm$ 0.86	Kushwaha <i>et al.</i> (1999)
2.	Jalauni		27.00 $\pm$ 0.20	24.60 $\pm$ 0.60	Sahana <i>et al.</i> (2003)
3.	Bellary		12.50 $\pm$ 0.10	11.20 $\pm$ 0.10	Jain <i>et al.</i> (2005a)
4	Mandya	10.00 $\pm$ 0.05			Jain <i>et al.</i> (2005 b)
5	Mecheri	8.10 $\pm$ 0.20	8.20 $\pm$ 0.30	7.20 $\pm$ 0.10	Karunanithi <i>et al.</i> (2005)
6.	Kenguri		12.00 $\pm$ 0.22	10.10 $\pm$ 0.08	Jain <i>et al.</i> (2006a)
7.	Hassan	10.60 $\pm$ 0.11			Jain <i>et al.</i> (2006b)
8.	Jaisalmeri	28.56 $\pm$ 0.16	30.19 $\pm$ 0.27	26.97 $\pm$ 0.14	Arora <i>et al.</i> (2007)
9.	Coimbatore	10.30 $\pm$ 0.20			Devendran <i>et al.</i> (2009)
10.	Vembur	11.20 $\pm$ 0.10	12.70 $\pm$ 0.10	11.10 $\pm$ 0.10	Chandran <i>et al.</i> (2009)
11.	Muzaffarnagri		55.49 $\pm$ 1.07	49.00 $\pm$ 0.39	Yadav <i>et al.</i> (2012)
12.	Ramnad White		10.70 $\pm$ 0.28	10.10 $\pm$ 0.10	Raja <i>et al.</i> (2012)
13.	Yalaga		12.50 $\pm$ 0.10	11.20 $\pm$ 0.10	Dayanand (2013)
14.	Mouli		20.47 $\pm$ 0.15	18.63 $\pm$ 0.08	Shashikant (2014)

2.10 Phenotypic correlations among different characters in sheep

Jain *et al.* (2017a) reported that body weight of adult Mouli sheep was correlated with body length, height at withers, chest girth, pouch girth, face length and ear length as 0.77, 0.77, 0.99, 0.76, 0.53 and 0.13, respectively.

Jain *et al.* (2017b) made study and reported that adult Yalaga sheep had 0.80, 0.82, 0.92, 0.82, 0.75 and 0.31 correlation with body length, height at withers, chest girth, pouch girth, face length and tail length, respectively.

2.11 Prediction equations

Prediction equation for Mouli lambs given by Jain *et al.* (2017a) was $Y = 2.3457 X^{0.5139}$ ($R^2 = 0.8479$) for male lambs and $Y = 0.702 X^{0.5194}$ ($R^2 = 0.9191$) for female lambs to predict body weight of Mouli lambs by using age of the lambs.

Jain *et al.* (2017b) gave prediction equation to predict the body weight of Yalaga lambs by using the age of lambs was $Y = 1.0663 X^{0.6288}$ ($R^2 = 0.9574$) for ram lambs and $Y = 2.0007 X^{0.4554}$ ($R^2 = 0.9415$) for ewe lambs.

2.12 Prediction of body weight with body measurements

Where weighing facilities weigh bridges are not available body measurements could be used to predict live weight fairly well in such situations (Berge, 1977).

For deciding suitable medicinal dose, feed amount and marketing of an animal on body weight (BW), prediction is necessary (Birteeb and Ozoje, 2012; Eydurán *et al.*, 2013).

The shepherds does not get remunerative price for their sheep in most of the markets in India are sheep and goats were not sold by body weight. It is necessary to have proper knowledge of approximate body weight of sheep in the absence of weighing facilitates in the market in order to get proper price for their produce.

The prediction of body weight and its relationships with other morphological measurements produce appreciable knowledge for breeding investigation with regard to meat production per animal (Janssens and Vandepitte, 2004; Yilmaz *et al.*, 2013; Iqbal *et al.*, 2013).

Biometrical observations recorded on UAS improved sheep reared at Veterinary College, Bidar revealed that the correlation coefficients between various biometrical measures were highly significant ($P < 0.01$) (Suranagi and Biradar, 2004). Out of the various equations tried, the better fit equations for estimating the body weight were $Y = 0.5764 \times L + 0.4164 \times G + 0.4597 \times H - 0.332$. After testing of hypothesis, the equation were $Y = 0.6149 \times L + 0.4164 \times G + 0.4692$ and $Y = 0.6306 (L \times G) - 0.4435$, where, Y = estimated weight (kg), L = body length (cm), G = chest girth (cm) and H = height (cm).

Ravimurugan *et al.* (2013) revealed that the best prediction equation for predicting the body weight from body measurements is by including the chest girth variable alone and the equation is $Y = -20.670 + 0.613 G$. Body length of sheep gave a 27.6 per cent estimation of body weight, 28.2 per cent body estimation as from height at withers, 69.1 per cent estimation of body weight depends on the chest girth, pouch girth contribute 57.9 per cent of body weight estimation. While, a huger percentage 78.3 per cent of body weight can be assessed from a combination of all parameters using equation.

$$Y = 32.213 + 0.182 L + 0.052 H + 0.353 G + 0.234 PG$$

Where,

Y = Estimated weight (kg), L = Body length (cm), H = Height (cm), G = Chest girth (cm) and PG = Pouch girth. Thus chest girth is the best predictor for the estimation of body weight and this alone contributed 69.1 per cent variation in the body weight of adult Kilakarsal sheep of Tamil Nadu.

Shashikant (2014) made study on mouli sheep and reported analysis for prediction of body weight from body measurements. Out of the various equations tried, the better fit equation for estimating the body weight were $Y = -109.5 + 0.36 L + 1.05 H + 0.17 G + 1.27 F$ after testing the hypothesis the equation are $Y = -89.52 + 0.56 L + 0.85 H + 0.23 G$, $Y = -88.4 + 0.66 L + 0.98 H$ and $Y = -63.53 + 1.36 L$ for males. Whereas, for and females the equation fitted were $Y = -40.82 + 0.275 L + 0.753 G$ and $Y = -26.29 + 0.87 L$, where, Y = Estimated weight (kg), L = Body length (cm), H = Height at wither (cm), G = chest girth (cm) and F = Flank width (cm).

III. MATERIAL AND METHODS

3.1 Material

The material required to conduct the research pertained to the information on morphological characters, sheep husbandry practices and reproduction performance of UAS breed of sheep maintained at the Main Agricultural Research Station (MARS) of University of Agricultural Sciences, Dharwad, Sheep Unit and ARS, Hanumanamatti Sheep Unit.

3.2 Location of the study

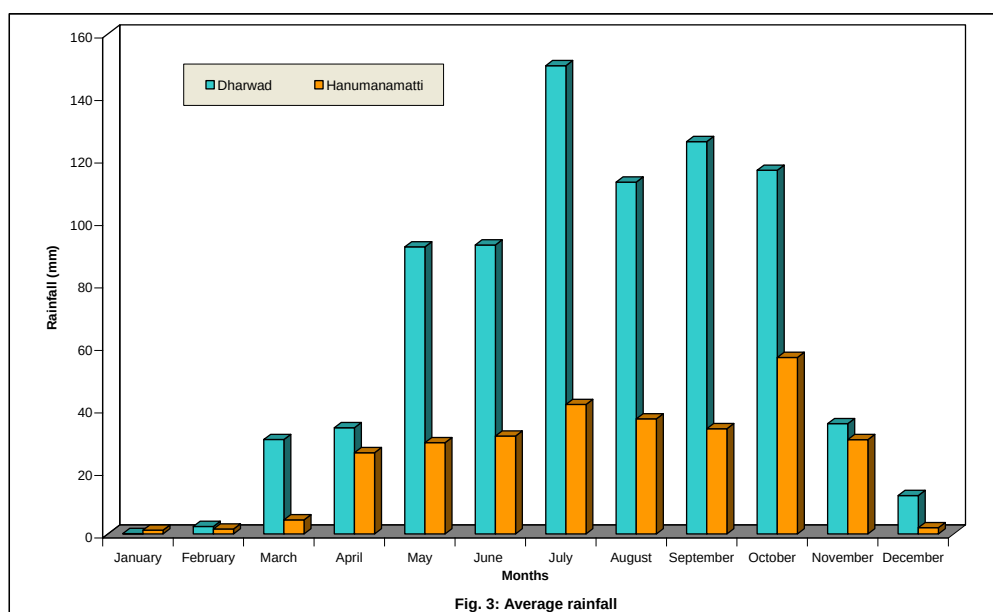
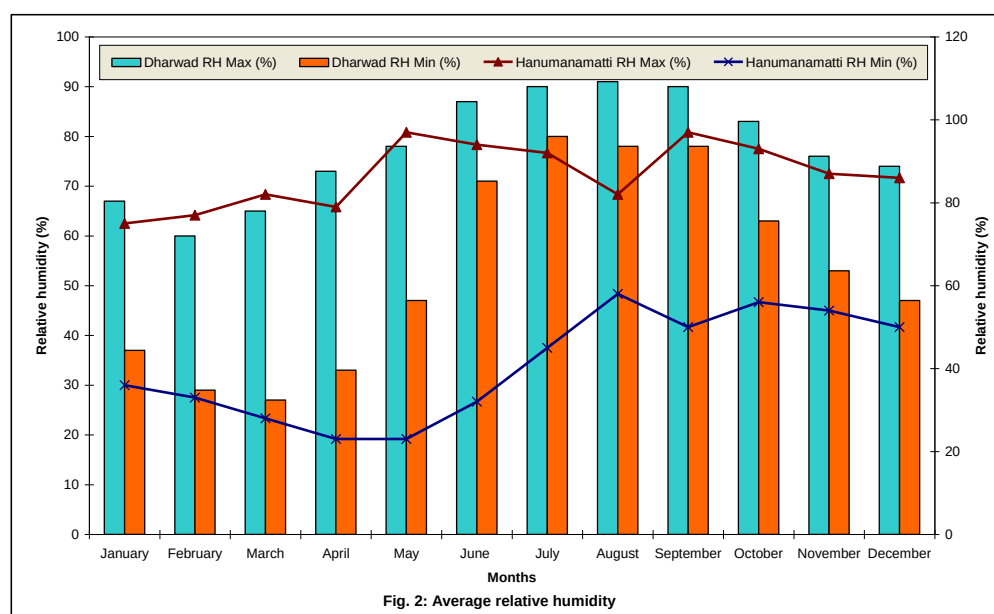
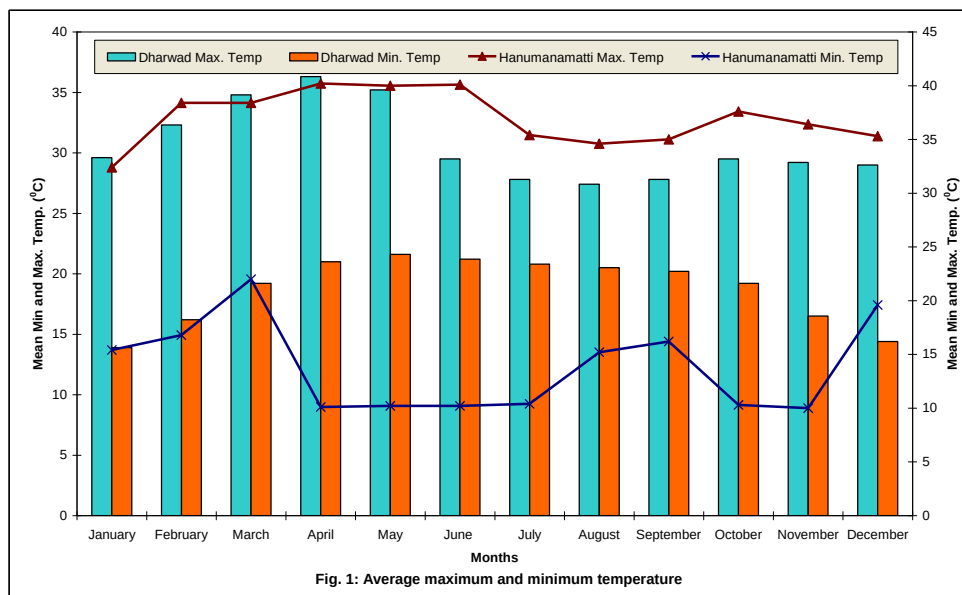
The research was conducted in two stations *viz.*, Dharwad and Hanumanamatti, Dharwad is situated in western sector of the northern half of Karnataka state. It encompasses an area of 4263 km² lying between the latitudinal parallels of 15° 02' and 15° 51' north and longitude of 73° 43' and 75° 35' east. Dharwad lies approximately 800 m above the mean sea level and the temperature ranges between 14 °C (January) to 36.5 °C (April).

The weather data on minimum and maximum temperature, relative humidity and rainfall is presented in Table 3.1 and Fig. 1 to 3. Dharwad district receives an average annual rainfall of 803 mm.

The second station, where the study was conducted at ARS, Hanumanamatti which comes under the district Haveri which is having an area of 4848 sq. km, it is located at a longitude of 75.33° E, latitude of 14.39' N with an altitude of 594.36 meters from mean sea level. Hanumanamatti is having climate of semi-arid, temperature ranges between 10.0 °C (November) to 40.2 °C (April). The station receives an average annual rainfall of 309 mm.

Table 3.1: Average weather data of Dharwad and Hanumanamatti

Months	Dharwad		Hanumanamatti		Dharwad		Hanumanamatti		Dharwad	Hanuma namatti
	Max. Temp (°C)	Min. Temp (°C)	Max. Temp (°C)	Min. Temp (°C)	RH Max (%)	RH Min (%)	RH Max (%)	RH Min (%)	Rain fall mm	Rain fall mm
January	29.6	13.9	32.4	15.4	67	37	75	36	0.1	1.19
February	32.3	16.2	38.4	16.8	60	29	77	33	2.4	1.57
March	34.8	19.2	38.4	22.0	65	27	82	28	30.2	4.52
April	36.3	21.0	40.2	101	73	33	79	23	34.0	26.01
May	35.2	21.6	40,0	10.2	78	47	97	23	91.9	29.20
June	29.5	21.2	40.1	10.2	87	71	94	32	92.5	31.33
July	27.8	20.8	35.4	10.4	90	80	92	45	149.9	41.44
August	27.4	20.5	34.6	15.2	91	78	82	58	112.6	36.82
September	27.8	20.2	35	16.2	90	78	97	50	125.6	33.67
October	29.5	19.2	37.6	10.3	83	63	93	56	116.4	56.50
November	29.2	16.5	36.4	10.0	76	53	87	54	35.3	30.17
December	29.0	14.4	35.3	19.6	74	47	86	50	12.3	1.99
Total Rainfall									803.2	294.41



3.3 Data collection

The data for the current research was collected through survey conducted in two stations viz., MARS, Dharwad and ARS, Hanumanamatti sheep units due to lack of proper awareness, the breed is reared in limited flocks. So for the study these two sheep units were taken.

Data pertaining to body weight and body biometry were recorded in 43 males, 187 females, 27 ewe lambs and 46 ram lambs. The adult males, females and lambs of UAS breed of sheep is shown in the Plate 1 to 3. The housing and flock is shown in Plate 4 to 6.

The body dimensions were measured using steel tape and restraining the animal squarely on the ground in an unforced position, the measurements were recorded to the nearest centimeter. The traits measured included body length (BL), height at withers (HW), chest girth (CG), pouch girth (PG), Ear length (EL), flank width (FW), hip bone (HB), pin bone (PB), hip to pin bone (HPB), tail length (TL) and face length (FL). These body measurements were measured as described by Tye *et al.* (2010). The plate 7 shows the method of measurement and weighing of body weight.

The body weight (BW) was recorded using a 100 kg circular dial hanging balance with a least count of 0.5 kg. Sheep were weighed in the morning before they were sent for grazing to minimize post prandial gut variation advance pregnant ewes were excluded. Age and sex of each animal were also recorded, age was recorded by referring the farm records maintained at the sheep unit farm and also age was estimated using dentition method because natural patterns of eruption of deciduous and permanent incisors in sheep and goats are strongly related to the age of the animals and the quality of the roughage feed.

The production aspects were recorded by referring the records maintained at the sheep unit farms of the station and also by interview with the management staff of labourers. The production aspects include, sex ratio, growth rate, mortality rate, lambing.



Plate 1: UAS Lamb



Plate 2: UAS Ewe



Plate 3: UAS Ram



Plate 4: UAS sheep Flock



Plate 5: Housing for sheep



Plate 6: Internal view of sheep house



Plate 7: Measurement and weighing of UAS breed of sheep

The production aspects were calculated by collecting the data from farm recorded and by interacting with the management staff and by using the formulae.

$$\text{Growth rate (g/day)} = \frac{\text{Weight of animal} - \text{Birth weight}}{\text{Age (days)}}$$

$$\text{Mortality rate (\%)} \begin{cases} \text{Lamb mortality} \\ \text{Adult mortality} \end{cases}$$

$$= \frac{\text{Number of animal died}}{\text{Number of animal exposed to the risk}} \times 100$$

$$\text{Lambing per cent in a year (\%)} = \frac{\text{Number of lambings}}{\text{Total number of adults}} \times 100$$

$$\text{Average number of adults} = \frac{\text{Number of adults at the beginning of the year} \pm \text{number of adults at the end of the year}}{2}$$

Sex ratio

$$\text{Number of male lambs : Number of female lambs}$$

Classification of the data

According to the sex the data was classified and within the sex the data classified into different age groups. The age groups were viz., 2 teeth, 4 teeth, 6 teeth and full mouth.

The number of males and females in group and sex area as follows

	Male	Female
2 teeth	6	37
4 teeth	3	62
6 teeth	6	38
Full mouth	1	4
Total	16	141

The data was also classified between the 2 stations viz., Dharwad and Hanumanamatti to study the variation between sheep reared at Dharwad and Hanumanamatti stations. The number of animals in each station were as follows.

	Dharwad	Hanumanamatti	Total
Male	17	26	43
Female	146	41	187
Total	163	67	230

Management practices

Housing, feeding and grazing of UAS breed of sheep were the management practices studied. The visual observations and interview with the management staff and labourers were the method of collection of data for realistic values.

Body measurements

The following different body measurements were studied

Traits	Definition
Body length	Distance from point of shoulders to the pin bones
Height at withers	Vertical distance from ground to the withers
Flank width	Highest distance between transverse process of lumbar vertebra
Chest girth	Circumference of the chest just behind the axial region
Pouch girth	Circumference of pouch just before hip bones
Ear length	Distance from base of the ear to the tip of the ear
Face length	Distance from forehead to tip of the nose
Tail length	Distance between last sacral vertebra to the tip of the tail
Hip bones	Distance between two hip bones
Pin bones	Distance between two pin bones
Hip to pin bones	Distance from hip bone to pin bone
Back length	Distance from wither to middle of the two hip bones

Statistical analysis

The collected data was analyzed separately for male and female in each age group. Means and standard errors for various traits were computed using standard formulae (Snedecar and Cochran, 1989). Group difference was detected using analysis of variance using following model.

By using Excel 2010 software the multiple linear correlations and multiple linear regression analysis was carried out.

The multiple linear regression equation for fitting standardized body weight and the body measurements equation are expressed below.

$$BW = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + e$$

Where,

a, intercept (with a value of zero); b_1 , b_2 , b_3 , b_4 and b_5 are regression coefficients of X_1 , X_2 , X_3 , X_4 , X_5 , respectively, X_1 = Body length, X_2 = Height of wither, X_3 = Chest girth, X_4 = Pouch girth, X_5 = flank width e is the error (residual) term. By using t – statistic the significance control for each of regression coefficients (intercept and slopes) was performed.

The appropriateness of the multiple regression analysis was decided by the coefficient of determination (R^2).

Analysis of variance

This was carried out to find the differences in sexes, stations and ages.

$$y_{ij} = \mu + x_i + e_{ij}$$

Where,

y_{ij} = j^{th} observation in i^{th} group

μ = Overall mean

x_i = Effect of i^{th} sex/age group/stations of a population ($i = 1, 2$ for sex, $i = 1, 2, 3, 4$ for age group and $i = 1, 2$ for stations)

e_{ij} = Random error with mean 0 and variance σ_e^2

Prediction of body weight from body measurements

Body measurements and body weight were taken for all males ($n = 43$) and female ($n = 187$) animals of different age groups (2 teeth, 4 teeth, 6 teeth and full mouth). Body measurements were taken for all ages except at birth. The body measurements taken using a steel tape included, the following traits : body length (BL), height at wither (H), chest girth (C), pouch girth (P) flank width (F) to study the linear – relationship between body weights with body measurements.

IV. RESULTS

4.1 Housing and management of UAS breed of sheep

UAS breed of sheep in UAS, Dharwad are housed in well constructed houses with adjoining paddocks enclosed by wire mesh. The animals are tagged for identification. The pregnant and lactating ewes are separately housed and the young ones below two months of age are not sent for grazing. They are allowed to suckle their dams before the mothers go out for grazing. During night, they are left with their mothers. The orphans are fed with the sheep milk. During the day time, succulent fodders like guinea grass and hybrid napier grass are offered to the young ones. The animals are grazed in the University premises from 9.30 am to 4.30 pm on all days. The animals are not offered any concentrates. The animals suffering from any disease or injuries are isolated and treated. Regular deworming, ecto-parasite control are carried out on both farms. The wool is sheared two times a year ie. during March and October. The animals are washed once in 15 days during summer and once a month during winter. Sunny days during rainy season are selected for washing the sheep. The animals are vaccinated on regular basis for various diseases like enterotoxaemia, foot and mouth disease, HS, PPR, blue tongue and sheep pox. The regular culling of non-productive animals is carried out. The male lambs which are not required for the breeding are sold in the age group of 6-12 months. The off type animals are removed from the farms as early as possible. The production, reproduction and health records along with the post – mortem records are maintained on the farms.

4.2 Constitution of UAS breed sheep farms and its performance

Table 4.2.1 Station and sex wise distribution of Flock

	Male		Female		Total
	DWD	HMT	DWD	HMT	
Adult (2 teeth and above)	2	14	114	27	157
Lambs	15	12	32	14	73
Total	17	26	146	41	230

4.2.1a Teeth wise distribution of the flock

Teeth	Male	Female	Total
Lambs	27	46	73
2 teeth	6	37	43
4 teeth	3	62	65
6 teeth and above	7	42	49
Total	43	187	230

There were highest lambs followed by 4 teeth and six teeth and above and 2 teeth animals. The flocks had more females and less males.

4.2.2 Lambing pattern in UAS breed of sheep

The overall lambing pattern observed in UAS breed of sheep was 116.05 per cent ranged from 100 to 135.70 per cent (Table 4.2.2). This indicated the satisfactory reproductive performance of UAS breed of sheep.

Table 4.2.2 Lambing percentage in UAS breed of sheep

Year	Lambing (%)
2017-18	100%
2016-17	119.71%
2015-16	111.5%
2014-15	135.7%
Over all	116.05%

4.2.3 Sex ratio in UAS breed of sheep

The overall sex ratio in the flock was 47.68:52.32 (M:F) which ranged from 41.25:58.75 (M:F) to 58.57:41.43 (M:F) (Table 4.2.3). It was found that the overall sex ratio was normal as there was no significant difference in the two sexes.

Table 4.2.3: Sex ratio in UAS breed of sheep

Year	Sex ratio (M:F)
2014-15	58.57 : 41.43
2015-16	41.25 : 58.75
2016-17	45.83 : 54.17
2017-18	46.25 : 53.75
Over all	47.68 :52.32

4.2.4 Mortality rate in UAS breed of sheep

The results of mortality rate are presented in Table 4.2.4. The overall mortality rate observed in UAS breed was 11.9, 7.80, 11.60 and 9.50 per cent in adult male, adult female and lamb male and lamb female, respectively. It was found that the lowest mortality rate was during 2016-17 and highest was during 2017-18 in both sexes of adult and lambs.

Table 4.2.4: Mortality rate in UAS breed of sheep

YEAR	Adult (%)		Lambs (%)	
	Male	Female	Male	Female
2014-15	9.09	2.10	5.66	8.33
2015-16	12.50	7.50	10.71	9.09
2016-17	0.00	0.00	0.51	1.51
2017-18	23.07	25.35	21.56	16.90
OVERALL	11.90	7.80	11.60	9.50

4.3 Performance of lambs of UAS breed**4.3.1 Growth rate of UAS breed of sheep**

The growth rates are grouped according to age in days and sex are presented in Table 4.3.1 and Fig. 4.

The overall growth rate of UAS breed of sheep lambs is 102.67 ± 3.84 g/day in male lambs and 82.47 ± 2.08 g/day in female lambs. The highest growth rate observed was 12.69 ± 8.17 g/day at the age of 60-90 days in male lambs and 93.78 ± 3.52 g/day at the age of 120-150 days in female lambs.

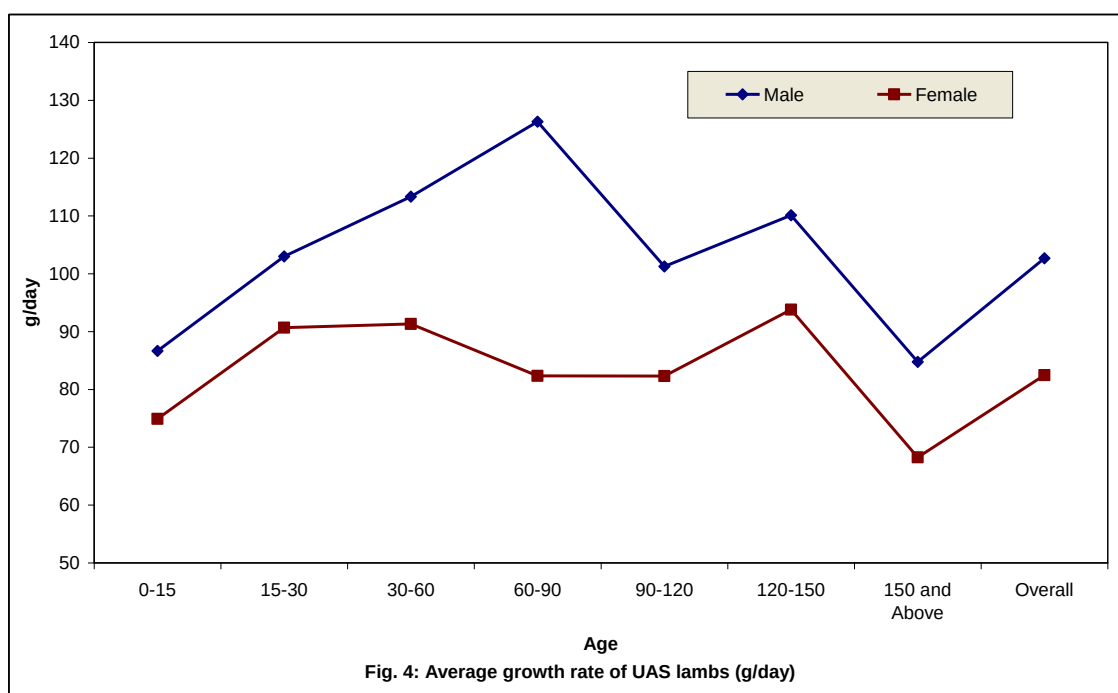
The growth rate ranged from 84.74 ± 2.00 g/day to 126.29 ± 8.17 g/day and 68.25 ± 1.67 to 93.78 ± 3.52 g/day in male and female lambs, respectively.

The growth rate of male lambs was more compare to female lambs of same age group. However, the difference was non-significant.

Table 4.3.1: Average growth rate of UAS lambs (g/day)

Sl. No.	Age	Male	Female
1	0-15	86.66 ± 13.40 (5)	74.89 ± 4.46 (3)
2	15-30	103.00 ± 10.97 (4)	90.66 ± 5.41 (5)
3	30-60	113.33 ± 1.66 (2)	91.33 ± 9.73 (5)
4	60-90	126.29 ± 8.17 (3)	82.35 ± 5.21 (9)
5	90-120	101.25 ± 3.56 (4)	82.31 ± 2.19 (9)
6	120-150	110.11 ± 2.78 (6)	93.78 ± 3.52 (6)
7	150 and Above	84.74 ± 2.00 (3)	68.25 ± 1.67 (9)
8	Overall	102.67 ± 3.84 (27)	82.47 ± 2.08 (46)

The figure in the parenthesis show the number of animals



4.3.2 Body measurement and average body weight of lambs

The average measurements of body length, pouch girth, height at withers, chest girth, back length, tail length, face length, ear length and body weight in various age groups is presented in Table 4.3.2.

Body weight taken in lambs showed no significant difference between the body weight of male and female lambs of UAS breed of sheep. There was no significant difference in body weight between the male and female lambs at birth and upto 60 days. There was a trend of increased body weight of ram lambs over ewe lambs after 60 days of age and the difference was highly significant ($P < 0.01$).

Table 4.3.2: Mean body measurements and body weight of UAS lambs

Age (days)	Sex	No	Body length	Height at withers	Back length	Chest girth	Pouch girth	Tail length	Face length	Ear length	Body weight
0-15	Male	5	28.00 ± 1.58 (24-32)	32.00 ± 1.67 (28-36)	25.20 ± 1.49 (20-28)	33.60 ± 1.12 (30-36)	31.40 ± 2.33 (25-38)	8.60 ± 0.40 (7-9)	11.00 ± 0.83 (9-13)	10.00 ± 0.32 (9-11)	3.40 ± 0.18 (3-4)
	Female	5	33.67 ± 0.89 (32-35)	35.34 ± 1.76 (32-38)	28.00 ± 1.00 (26-29)	41.34 ± 3.67 (34-45)	52.00 ± 6.51 (39-59)	10.67 ± 0.67 (10-12)	13.00 ± 0.00 (13)	11.67 ± 0.89 (10-13)	4.67 ± 0.89 (3-6)
15-30	Male	4	33.00 ± 1.08 (31-36)	34.25 ± 0.48 (33-35)	28.75 ± 0.63 (27-30)	47.50 ± 1.55 (43-50)	44.25 ± 2.78 (39-50)	8.50 ± 0.50 (7-9)	12.00 ± 0.70 (10-13)	10.50 ± 0.29 (10-11)	5.13 ± 0.31 (4.5-6)
	Female	5	32.40 ± 0.75 (30-34)	32.60 ± 0.87 (30-35)	27.80 ± 0.37 (27-29)	45.40 ± 0.24 (45-46)	41.40 ± 2.11 (35-46)	10.80 ± 0.58 (9-12)	16.60 ± 0.68 (15-18)	13.40 ± 0.24 (13-14)	4.60 ± 0.18 (4-5)
30-60	Male	2	35.50 ± 0.50 (35-36)	38.50 ± 0.50 (38-39)	29.50 ± 0.50 (29-30)	48.50 ± 0.50 (48-49)	44.50 ± 1.50 (43-46)	11.00 ± 2.00 (9-13)	13.50 ± 1.50 (12-15)	12.00 ± 2.00 (10-14)	9.00 ± 0.00 (99)
	Female	5	33.6 ± 1.02 (30-36)	36.80 ± 0.73 (35-39)	30.20 ± 0.37 (29-31)	47.4 ± 0.51 (46-49)	42.8 ± 1.28 (39-46)	10.80 ± 0.37 (10-12)	15.40 ± 0.24 (15-16)	12.40 ± 0.40 (12-14)	7.60 ± 0.60 (6-9)
60-90	Male	3	39.66 ± 0.88 (38-41)	42.00 ± 1.15 (40-44)	30.33 ± 0.33 (30-31)	52.33 ± 1.20 (50-54)	58.33 ± 1.20 (56-90)	12.33 ± 1.33 (11-15)	14.66 ± 0.33 (14-15)	12.00 ± 0.58 (11-13)	13.33 ± 0.66 ** (12-14)
	Female	8	40.38 ± 1.28 (33-43)	38.75 ± 0.98 (34-41)	31.38 ± 0.88 (26-34)	48.50 ± 0.94 (44-51)	50.63 ± 2.63 (35-58)	11.50 ± 0.42 (10-13)	14.88 ± 0.47 (12-16)	12.25 ± 0.16 (12-13)	9.37 ± 0.53** (7-12)

Contd...

Age (days)	Sex	No	Body length	Height at withers	Back length	Chest girth	Pouch girth	Tail length	Face length	Ear length	Body weight
90-120	Male	4	43.25 ± 0.25 (43-44)	44.50 ± 0.50 (43-45)	32.00 ± 0.71 (30-33)	54.00 ± 0.01 (54)	59.50 ± 0.87 (57-61)	11.50 ± 0.29 (11-12)	16.00 ± 0.71 (15-18)	12.50 ± 0.29 (12-13)	14.25 ± 0.48** (13-15)
	Female	8	42.13 ± 0.83 (38-45)	43.25 ± 0.49 (41-45)	32.38 ± 0.59 (30-34)	52.75 ± 0.37 (51-54)	56.25 ± 1.16 (50-60)	10.38 ± 0.63 (8-13)	14.13 ± 0.29 (13-15)	11.75 ± 0.41 (11-14)	11.88 ± 0.29** (11-13)
120-150	Male	6	44.33 ± 0.21 (44-45)	48.33 ± 0.66 (46-50)	39.33 ± 1.71 (34-44)	58.16 ± 1.27 (55-62)	67.50 ± 1.91 (58-70)	12.67 ± 0.56 (11-15)	14.50 ± 0.72 (12-17)	12.50 ± 0.34 (12-14)	18.50 ± 0.43** (17-20)
	Female	5	45.60 ± 0.24 (45-46)	47.20 ± 0.58 (46-49)	37.40 ± 1.44 (33-40)	62.20 ± 1.39 (59-67)	65.20 ± 2.96 (55-70)	11.00 ± 0.32 (10-12)	14.80 ± 0.80 (13-17)	12.40 ± 0.40 (11-13)	16.40 ± 0.51** (15-18)
150 and above	Male	3	55.33 ± 0.89 (54-57)	52.00 ± 1.00 (50-53)	45.34 ± 1.45 (43-48)	60.66 ± 2.34 (57-65)	71.66 ± 3.17 (68-78)	12.00 ± 0.57 (11-13)	15.67 ± 0.67 (15-17)	13.34 ± 0.34 (13-14)	24.00 ± 0.58** (23-25)
	Female	8	52.13 ± 1.62 (45-57)	53.88 ± 1.61 (44-59)	41.63 ± 0.63 (40-45)	66.50 ± 2.69 (49-72)	69.38 ± 0.38 (68-71)	11.13 ± 0.48 (9-13)	12.25 ± 0.59 (10-15)	11.50 ± 0.50 (10-13)	19.50 ± 0.46** (18-22)

The figure in the parenthesis show the range of the respective body measurements

** P<0.01

4.4 Body measurement of adult UAS sheep

The average body productive morphological characters like body length, height at withers, chest girth, pouch girth, back length, flank width and body weight and are presented in Table 4.4 and other body measurements like face length, hip bones, pin bones, hip to pin bones, tail length and ear length are presented in Table 4.4a.

4.4.1 Body length

The average body length of UAS breed of sheep was 59.93 ± 3.23 and 58.40 ± 0.44 in male and females, respectively (Table 4.4). Body length at 6 teeth was highly significant (< 0.01) longer than 4 teeth and 2 teeth. There was highly significant (< 0.01) difference between the adult male and female body length males are longer than females.

4.4.2 Height at withers

The average of height at withers in males and female of UAS breed of sheep was 49.93 ± 3.18 and 54.58 ± 0.34 cm respectively (Table 4.4). Height at withers in female and highly significant (< 0.01) taller than males, while 6 teeth sheep are highly significant (< 0.01) than 4 teeth and 2 teeth sheep.

4.4.3 Back length

The average back length of males and females of UAS breed of sheep was 39.18 ± 1.16 and 42.92 ± 0.35 cm, respectively (Table 4.4). Back length in adult 6 teeth sheep was highly significant (< 0.01) than 4 teeth and 2 teeth sheeps and back length in adult females was significantly (< 0.01) longer than adult males and 6 teeth sheep had significantly (< 0.01) longer back length than 4 teeth and 2 teeth sheep.

4.4.4 Chest girth

The average chest girth in males and females of UAS breed of sheep was 71.06 ± 1.79 and 73.16 ± 0.46 cm respectively (Table 4.4) chest girth in 6 teeth sheep was significantly (< 0.01) more broader than 4 teeth and 2 teeth sheep and there was no significant difference between the male and female.

Table 4.4: Mean of productive morphological characters

	2 tooth		4 tooth		6 tooth		Full mouth		Overall	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
No of animals	6	37	3	62	7	38	-	4	16	141
Body length (cm)	44.83 ± 3.97 (34-56)	55.97 ± 051 (50-65)	59.66 ± 5.17 (54-70)	59.03 ± 0.63 (48-75)	59.28 ± 5.08** (40-74)	59.34 ± 1.02** (40-70)	-	62.25 ± 3.59 (53-70)	59.93 ± 3.23 (34-74)	58.40 ± 0.44 (40-75)
Height at withers(cm)	41.16 ± 4.78 (30-55)	53.59 ± 0.38 (48-57)	56.66 ± 3.71 (52-64)	54.97 ± 0.34 (41-60)	54.57 ± 4.60** (35-68)	54.58 ± 1.07** (35-62)	-	57.75 ± 1.11 (55-60)	49.93 ± 3.18 (30-68)	54.58 ± 0.34 (35-62)
Back length (cm)	36.83 ± 1.13 (33-41)	40.70 ± 0.40 (35-46)	39.00 ± 2.51 (36-44)	43.24 ± 0.50 (35-51)	41.28 ± 2.10** (32-50)	44.11 ± 0.77** (33-51)	-	47.25 ± 2.17 (43-51)	39.18 ± 1.16 (32-50)	42.92 ± 0.35 (33-51)
Chest girth (cm)	63.83 ± 1.04 (60-67)	70.46 ± 0.86 (60-78)	74.00 ± 5.56 (67-85)	73.08 ± 0.63 (60-90)	76.00 ± 1.00** (72-81)	75.63 ± 0.91** (63-85)	-	76.00 ± 1.58 (73-80)	71.06 ± 1.79 (60-85)	73.16 ± 0.46 (60-90)
Pouch girth (cm)	71.16 ± 0.94 (67-73)	74.86 ± 0.96 (58-85)	77.00 ± 4.00 (73-85)	77.52 ± 0.65 (62-88)	78.00 ± 2.13** (69-86)	79.36 ± 1.05** (64-89)	-	83.00 ± 2.38 (78-88)	75.25 ± 1.40 (67-86)	77.48 ± 0.50 (58-89)
Flank width (cm)	11.00 ± 0.37 (10-12)	10.22 ± 0.14 (8-12)	11.33 ± 0.88 (10-13)	10.52 ± 0.11 (9-13)	12.57 ± 0.36 (11-14)	10.97 ± 0.17 (9-13)	-	11.25 ± 0.75(10-13)	11.75 ± 0.30 (10-14)	10.59 ± 0.08(8-13)
Body weight (cm)	26.16 ± 1.85 (20-33)	26.65 ± 0.61 (21-35)	37.33 ± 8.35 (28-54)	29.48 ± 0.43 (23-40)	38.57 ± 2.11** (30-46)	32.97 ± 0.61** (25-40)	-	36.00 ± 2.31 (32-40)	33.68 ± 2.28 (20-54)	29.87 ± 0.37 (21-40)

The figures in the parenthesis shows the range of body measurements

**P<0.01

Table 4.4a: Mean body measurements

	2 tooth		4 tooth		6 tooth		Full mouth		Overall	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
No of animals	6	37	3	62	7	38	-	4	16	141
Face length (cm)	17.33 ± 0.33 (16-18)	16.48 ± 0.22(13-20)	19.66 ± 1.20(18-22)	17.33 ± 0.17 (14-21)	19.43 ± 0.68(18-23)	17.97 ± 0.28 (14-22)	-	19.50 ± 1.19 (18-23)	18.68 ± 0.45 (16-23)	17.30 ± 0.14 (13-23)
Hip bones (cm)	8.83 ± 0.17(8-9)	9.26 ± 0.16 (8-11)	9.33 ± 0.66(8-10)	9.94 ± 0.13 (8-13)	10.57 ± 0.61(8-13)	10.42 ± 0.18 (8-12)	-	11.00 ± 0.57 (10-12)	9.68 ± 0.35 (8-13)	9.92 ± 0.09 (8-13)
Pin bones (cm)	4.00 ± 0.22 (3..5-5)	5.75 ± 0.11 (4-7)	4.66 ± 0.66 (4-6)	6.05 ± 0.12 (4-8)	5.50 ± 0.52 (4-7.5)	10.42 ± 0.18 (4-9)	-	8.00 ± 0.71 (7-10)	4.70 ± 0.30 (3.5-7.5)	6.03 ± 0.08 (4-10)
Hip to Pin bones (cm)	3.30 ± 0.30 (3-5)	6.38 ± 0.18 (4-11)	4.66 ± 0.66 (4-6)	6.23 ± 0.19 (2.5-12)	5.43 ± 0.75 (3-8)	6.52 ± 0.33 (3-12)	-	8.25 ± 0.85 (6-10)	4.68 ± 0.39 (3-8)	6.40 ± 0.14 (2.5-12)
Tail length (cm)	12.66 ± 0.42(11-14)	11.35 ± 0.23(9-14)	14.00 ± 1.15(12-16)	11.79 ± 0.16 (9-14)	14.00 ± 0.48 (12-16)	11.73 ± 0.24 (6-14)	-	13.25 ± 0.48 (12-14)	13.50 ± 0.35 (11-16)	11.70 ± 0.12 (6-14)
Ear length (cm)	13.33 ± 0.33 (12-14)	12.89 ± 0.16 (11-15)	13.33 ± 0.33 (13-14)	13.25 ± 0.12 (11-16)	13.14 ± 0.34 (12-15)	13.39 ± 0.13 (12-15)	-	14.25 ± 0.63 (13-16)	13.25 ± 0.19 (12-15)	13.23 ± 0.08 (11-16)

The figures in the parenthesis shows the range of body measurements

4.4.5 Pouch girth

The average pouch girth in males and females of UAS breed of sheep was 75.25 ± 1.41 and 77.48 ± 0.50 cm, respectively (Table 4.4). The pouch girth in males was significantly (< 0.01) more broader than females. Similarly 6 teeth sheep and more significant (< 0.01) pouch girth than 4 teeth and 2 teeth sheep.

4.4.6 Flank width

The average flank width and about males and females of UAS breed of sheep was 11.75 ± 0.30 and 10.59 ± 0.08 cm, respectively (Table 4.4) and the difference was not significant.

4.4.7 Body weight

The mean body weight of adult males and females of UAS breed of sheep was 33.687 ± 2.28 and 29.87 ± 0.37 kg, respectably (Table 4.4). There was no significant difference in the body weight of males and females but 6 teeth sheep are having highly significant (< 0.01) heavier body weight than that of 4 teeth and 2 teeth sheep.

4.4.8 Measurements of non-productive traits of UAS breed of sheep

4.4.8a Face length

The average of the face lengths of adult males and females was 18.68 ± 0.45 and 17.30 ± 0.14 cm, respectively (Table 4.4a).

4.4.8b Hip bones

The average hip bones distance of adult males and female of UAS breed of sheep was 9.68 ± 0.35 and 9.92 ± 0.09 cm, respectively (Table 4.4a).

4.4.8c Pin bones

The average pin distance between the pin bones in adult males and adult females of UAS breed of sheep was 4.70 ± 0.30 (Table 4.4a) and 6.03 ± 0.08 cm, respectively. It

was observed that the adult females had more distance between the pin bones than the males.

4.4.8d Hip to pin bones

The average distance between hip to pin bones in adult males and adult females was 4.68 ± 0.39 and 6.40 ± 0.14 cm, respectively (Table 4.4a).

4.4.8e Ear length

The average ear length of adult males and females of UAS breed of sheep was 13.25 ± 0.19 and 13.23 ± 0.08 cm, respectively (Table 4.4a).

4.4.8f Tail length

The average tail length in males and females of UAS breed of sheep is 13.50 ± 0.35 and 11.70 ± 0.12 cm, respectively (Table 4.4a).

4.4.9 Comparison between Dharwad and Hanumanamatti stations

The average productive morphological characters like body length, pouch girth, height at withers, chest girth, back length and body weight grouped according to stations (Dharwad and Hanumanamatti) and sex are presented in Table 4.4.9. while, other body measurements like flank width, hip bone, pin bones, tail length, face length and ear length are presented in Table 4.4.9a.

Dharwad sheep had significantly (< 0.01) longer body length than Hanumanamatti sheep and pouch girth, height at withers, chest girth and back length in Dharwad station sheep are highly significantly (< 0.01) different than Hanumanamatti station sheep but the body weight of Dharwad and Hanumanamatti sheep are non-significant.

Table 4.4.9: Body measurements and Body weight (mean S.E)of UAS Breed sheep maintained at Dharwad and Hanumanamatti

Body Parameters	Males		Females		Overall	
	Dharwad	Hanumanamatti	Dharwad	Hanumanamatti	Dharwad	Hanumanamatti
Number of observation	2	14	114	27	116	41
Body length	73.00 ± 1.00** (72-74)	51.21 ± 3.04** (34-70)	59.38 ± 0.42** (50-73)	54.26 ± 1.11** (40-64)	59.62 ± 0.45** (50-75)	53.21 ± 1.27** (34-70)
Pouch girth	84.50 ± 1.50** (83-86)	73.92 ± 1.23** (67-85)	78.82 ± 0.47** (64-89)	71.78 ± 1.22** (58-85)	78.92 ± 0.46** (64-89)	72.51 ± 0.91** (58-85)
Height at withers	63.00 ± 5.00** (58-68)	48.07 ± 3.31** (30-64)	55.54 ± 0.24** (49-62)	50.56 ± 1.24** (35-60)	55.67 ± 0.26** (49-68)	49.71 ± 1.38** (30-64)
Chest girth	78.50 ± 2.50** (76-81)	70.00 ± 1.86** (60-85)	74.27 ± 0.46** (60-90)	68.48 ± 0.97** (60-76)	74.34 ± 0.46** (60-90)	69.00 ± 0.89** (60-85)
Back length	47.00 ± 3.00** (44-50)	38.07 ± 0.96** (32-44)	43.89 ± 0.35** (36-51)	38.85 ± 0.61** (33-49)	43.93 ± 0.34** (36-51)	38.58 ± 0.51** (32-49)
Body weight	45.50 ± 0.50 (45-46)	32.00 ± 2.27 (20-54)	29.78 ± 0.41 (21-40)	30.22 ± 0.85 (24-40)	30.05 ± 0.45 (21-46)	30.83 ± 0.95 (20-54)

Figures in the parenthesis indicate the range of the characters

** P<0.01

Table 4.4.9a: Body measurements of UAS sheep maintained at Dharwad and Hanumanamatti (Non-productive characters)

Parameters	Males		Females		Overall	
	Dharwad	Hanumanamatti	Dharwad	Hanumanamatti	Dharwad	Hanumanamatti
Number of observation	2	14	114	27	116	41
Flank width	12.50 ± 1.50 (11-14)	11.64 ± 0.31 (10-13)	10.47 ± 0.09 (8-13)	11.11 ± 0.20 (9-13)	1.51 ± 0.09 (6-14)	11.29 ± 0.17 (9-13)
Hip bone	11.50 ± 1.50 (10-13)	9.43 ± 0.31 (8-12)	10.04 ± 0.11 (8-13)	9.44 ± 0.20 (8-12)	10.06 ± 0.11 (8-13)	9.40 ± 0.17 (8-12)
Pin Bone	7.25 ± 0.25 (7-7.5)	4.43 ± 0.22 (3.5-6)	6.33 ± 0.08 (5-10)	4.81 ± 0.13 (4-7)	6.34 ± 0.08 (5-10)	4.68 ± 0.12 (3.5-7)
Hip to Pin Bones	8.00 ± 0.00 (8)	4.21 ± 0.26 (3-6)	6.90 ± 0.12 (5-12)	4.29 ± 0.19 (2.5-6)	6.92 ± 0.12 (5-12)	4.27 ± 0.15 (2.5-6)
Tail length	14.00 ± 0.00 (14)	13.43 ± 0.40 (11-16)	11.89 ± 0.11 (9-14)	10.89 ± 0.37 (6-14)	11.93 ± 0.11 (9-14)	11.75 ± 0.34 (6-16)
Face length	21.50 ± 1.50 (20-23)	18.28 ± 0.38 (16-22)	17.40 ± 0.16 (13-23)	16.85 ± 0.23 (14-19)	17.47 ± 0.17 (13-23)	17.34 ± 0.23 (14-22)
Ear length	14.00 ± 1.00 (13-15)	13.14 ± 0.18 (12-14)	13.20 ± 0.09 (11-16)	13.33 ± 0.14 (12-15)	13.22 ± 0.09 (11-16)	13.27 ± 0.11 (12-15)

Figures in the parenthesis indicate the range of the characters

4.5 Phenotypic correlation among different body measurements of UAS breed of sheep

4.5.1 Ram lambs

In ram lamb body length was highly correlated with body weight (0.96), height at withers (0.95) and pouch girth (0.91), pouch girth is highly correlated with body weight (0.94), chest girth (0.94) and height at withers (0.93). Height at withers was highly correlated with body weight (0.97), back length (0.91) and chest girth (0.90). Chest girth was highly correlated with body weight (0.89) and back length with body weight (0.91) (Table 4.5.1).

Table 4.5.1: Phenotypic correlations among different characters in ram lambs

Character	Body length (cm)	Height at withers (cm)	Back length (cm)	Chest girth (cm)	Pouch girth (cm)	Tail length (cm)	Face length (cm)	Ear length (cm)
Body length (cm)	1.00							
Height at withers	0.95	1.00						
Back length	0.89	0.91	1.00					
Chest girth	0.89	0.90	0.82	1.00				
pouch girth	0.91	0.93	0.86	0.94	1.00			
Tail length	0.67	0.73	0.52	0.67	0.71	1.00		
Face length	0.74	0.75	0.58	0.71	0.72	0.55	1.00	
Ear length	0.76	0.76	0.64	0.72	0.76	0.79	0.71	1.00
Body weight (kg)	0.96	0.97	0.91	0.89	0.94	0.72	0.68	0.75

4.5.2 Ewe lambs

In female lambs body length was highly correlated with body weight (0.94), back length (0.90) and there was no correlation with tail length. Pouch girth was highly correlated with body weight (0.89) and height at withers (0.89), height with bodyweight (0.96), chest girth (0.95) and back length (0.92) (Table 4.5.2).

Chest girth was highly correlated with body weight (0.93) and back length (0.91). Back length was highly correlated with body weight (0.95) (Table 4.5.2).

Table 4.5.2: Phenotypic correlations among different characters in ram lambs

Character	Body length (cm)	Height at withers	Back length	Chest girth	pouch girth	Tail length	Face length	Ear length
Body length (cm)	1							
Height at withers	0.89	1.00						
Back length	0.90	0.92	1.00					
Chest girth	0.82	0.95	0.91	1.00				
pouch girth	0.89	0.89	0.91	0.84	1.00			
Tail length	0.00	0.06	0.07	0.08	0.06	1.00		
Face length	-0.58	-0.57	-0.49	-0.47	-0.49	0.32	1.00	
Ear length	-0.48	-0.35	-0.36	-0.28	-0.38	0.53	0.68	1.00
Body weight (kg)	0.94	0.96	0.95	0.93	0.89	0.01	-0.55	-0.40

4.5.3 Phenotypic correlations in rams

In rams of UAS breed of sheep body length was moderately highly correlated highly with height at withers (0.84), body weight (0.78), pouch girth (0.80) and back length (0.74) (Table 4.5.3). Height at withers was correlated with body weight (0.72), hip bones (0.69) and chest girth (0.69) (Table 4.5.3). Pouch girth was correlated with body weight (0.99), face length (0.91) and chest girth (0.86) (Table 4.4.2). Back length was moderately highly correlated with body weight (0.75) and pin bones (0.72) (Table 4.5.3).

4.5.4 Phenotypic correlations in ewes

Body length was moderately correlated with chest girth (0.65), pouch girth with chest girth (0.88) and body weight (0.66). height at withers with chest girth and pin bones (0.42), chest girth with body weight (0.64) and pin bones (0.54), back length with pin bones (0.52) and there was no correlation with flank width (Table 4.5.4).

Table 4.5.3: Phenotypic correlations among different characters in rams

Characters	Body length (cm)	Height at withers (cm)	Back length	Chest girth (cm)	pouch girth	Flank width	Hip bones	pin bones	Hip to Pin bones	Tail length	Face length	Ear length
Body length (cm)	1.00											
Height at withers	0.94	1.00										
Back length	0.74	0.60	1.00									
Chest girth	0.71	0.69	0.63	1.00								
pouch girth	0.80	0.74	0.78	0.86	1.00							
Flank width	0.34	0.32	0.32	0.74	0.59	1.00						
Hip bones	0.67	0.69	0.44	0.67	0.74	0.57	1.00					
pin bones	0.63	0.46	0.72	0.69	0.77	0.46	0.57	1.00				
Hip to Pin bones	0.71	0.56	0.61	0.58	0.69	0.33	0.59	0.70	1.00			
Tail length	0.36	0.31	0.29	0.56	0.52	0.46	0.42	0.56	0.40	1.00		
Face length	0.72	0.66	0.70	0.82	0.91	0.59	0.64	0.74	0.66	0.58	1.00	
Ear length	0.51	0.38	0.37	0.19	0.32	0.28	0.26	0.23	0.45	0.00	0.44	1.00
Body weight (kg)	0.78	0.72	0.75	0.95	0.93	0.65	0.64	0.71	0.67	0.52	0.86	0.29

Table 4.5.4: Phenotypic correlations among different characters in ewes

Characters	Body length (cm)	Height at withers	Back length	Chest girth	pouch girth	Flank width	Hip bones	pin bones	Hip to Pin bones	Tail length	Face length	Ear length
Body length (cm)	1.00											
Height at withers	0.45	1.00										
Back length	0.41	0.41	1.00									
Chest girth	0.65	0.42	0.52	1.00								
pouch girth	0.60	0.51	0.53	0.88	1.00							
Flank width	0.15	-0.06	0.00	0.13	0.06	1.00						
Hip bones	0.45	0.21	0.29	0.52	0.49	0.25	1.00					
pin bones	0.54	0.42	0.52	0.54	0.55	0.06	0.45	1.00				
Hip to Pin bones	0.50	0.42	0.48	0.49	0.48	0.00	0.46	0.69	1.00			
Tail length	0.18	0.33	0.29	0.18	0.35	-0.09	0.03	0.21	0.19	1.00		
Face length	0.48	0.26	0.36	0.56	0.52	0.40	0.43	0.52	0.37	0.20	1.00	
Ear length	0.23	0.07	0.07	0.28	0.32	0.35	0.25	0.20	0.13	0.05	0.40	1.00
Body weight (kg)	0.50	0.29	0.40	0.64	0.66	0.29	0.45	0.33	0.22	0.19	0.51	0.29

4.6 Prediction of body weight from body measurements

The prediction equations to predict the body weight in various category of animals were developed. The results of the study are presented in the following section.

The overall regression equation using height at withers, body length and pouch girth gave an R^2 value of 95.80 % (Table 4.6.1). The data was further subjected to develop prediction equations for body weight of ram lambs.

Table 4.6.1: Multiple regression Analysis of ram lambs

Parameter estimation					
Variable	df	Parameter estimate	Standard error	T value	P > (t)
Intercept	1	-21.2294	2.2361	- 9.4941	2.02 E 09
Height at withers (H)	1	0.3614	0.1537	2.3509	0.0277
Body length (L)	1	0.3012	0.1136	2.6516	0.0142
Pouch girth (P)	1	0.1243	0.0573	2.1681	0.0407
$R^2 = 95.80\%$					

The prediction equations using height alone as presented in table 4.6.1a gave an R^2 value of 93.10%. This was found to be sufficient for predicting the body weight of ram lambs under field conditions.

Table 4.6.1a: Prediction equations and coefficient of determination in different body measurements in ram lambs.

Parameters	Prediction equation	R^2 (%)
H	$Y = - 26.04 + 0.92 H$	93.10%
H + L	$Y = - 23.94 + 0.54 H + 0.35 L$	94.90%
H + L + P	$Y = -21.23 + 0.36 H + 0.30L + 0.12 P$	95.80%

The overall regression equation using all the productive characters gave an R^2 value of 96.40 % (Table 4.6.2) in ewe lambs. The data was further subjected to develop prediction equations for body weight of ewe lambs.

Table 4.6.2: Multiple regression Analysis on Ewe Lambs

Parameter estimation					
Variable	df	Parameter estimation	Standard error	T value	P >(t)
Intercept	1	-20.5706	1.1302	-18.1994	5.89E-21
Height at withers (H)	1	0.1773	0.0828	2.1405	0.0384
Back length (B)	1	0.2489	0.1063	2.3420	0.0242
Body length (L)	1	0.2693	0.0580	4.6440	3.65E-05
Pouch girth (P)	1	-0.0335	0.0387	-0.8674	0.3908
Chest girth (G)	1	0.1306	0.0590	2.2129	0.0327
$R^2 = 96.40\%$					

The prediction equations using height at withers alone as presented in table 4.6.2a gave an R^2 value of 91.40%. This was found to be sufficient for predicting the body weight of ewe lambs under field conditions.

Table 4.6.2a: Prediction equations for body weight of Ewe lambs by using different body measurements

Parameters	Prediction equation	R^2 (%)
H	$Y = -16.55 + 0.66 H$	91.40%
H + B	$Y = -20.13 + 0.37 H + 0.47 B$	94.40%
H + B + L + P + G	$Y = -20.57 + 0.18 H + 0.25 B + 0.27 L - 0.03 P + 0.13 G$	96.40%

The overall regression equation using chest girth, pouch girth, and body length gave an R^2 value of 95.71 % (Table 4.6.3) in rams. The data was further subjected to develop prediction equations for body weight of rams.

Table 4.6.3: Multiple Regression on rams

Variable	df	Parameter estimation	Standard error	t value	P > (t)
Intercept	1	-70.8319	7.746	- 9.145	9.33E07
Chest girth (G)	1	0.71398	0.1484	4.8112	0.00043
Pouch girth (P)	1	0.61069	0.2348	2.601	0.0232
Body length (L)	1	0.19976	0.1892	0.1892	0.312
$R^2 = 95.71\%$					

The prediction equations using chest girth alone as presented in table 4.6.3a gave an R^2 value of 89.42%. This was found to be sufficient for predicting the body weight of rams under field conditions.

Table 4.6.3a: Prediction equations and coefficient of determination in different body measurements for rams

Parameters	Prediction equation	R^2 (%)
G	$Y = - 52.07 + 1.21 G$	89.42%
G + P	$Y = - 72.92 + 0.70 G + 0.76 P$	95.31%
G + P + B	$Y = -70.83 + 0.71 G + 0.61 P + 0.20 B$	95.71%

The overall regression equation using pouch girth, body length, height at withers and chest girth gave an R^2 value of 46.14 % (Table 4.6.4) in rams. The data was further subjected to develop prediction equations for body weight of ewes

Table 4.6.4: Multiple Regression of ewes

Parameter Estimation					
Variable	df	Parameter estimation	Standard error	T value	P > (t)
Intercept	1	-8.7371	4.4013	-1.9838	0.0492
Pouch girth (P)	1	0.3426	0.1029	3.3270	0.0012
Body length (L)	1	0.1325	0.0721	1.8370	0.0684
Height at withers (H)	1	-0.0996	0.0812	-1.2029	0.2311
Chest girth (G)	1	0.1318	0.1125	1.1719	0.2433
$R^2 = 46.14\%$					

Table 4.6.4a: Prediction equations and coefficient of determination in different body measurements for ewes.

Parameters	Prediction equation	R ² (%)
P	$Y = -7.69 + 0.48 P$	43.05
P + L	$Y = -10.19 + 0.41P + 0.14 L$	44.84
P + L + H	$Y = -7.49 + 0.44 P + 0.16 L - 0.11 H$	45.59
P + L + H + G	$Y = -8.73 + 0.34 P + 0.13 L - 0.10 H + 0.13 G$	46.14

Table 4.6.4a showed that the R² values of various prediction equations did not describe the variations in the body weight of ewes. This was expected as the correlations among the different characters in ewes were low. However, the prediction equation using pouch girth was recommended for use in the field conditions.

V. DISCUSSION

India is a country known for its animal genetic resources. The sheep is a small ruminant with a capacity to convert stubbles, farm wastes and weeds in to meat and wool. Hence, it plays a major role in farming activities and contributes substantially to the agrarian economy. A lot of cross breeding programmes have been done in Sheep and there are many breeds evolved in the process. UAS breed of sheep is the result of three breed cross between Deccani, Mandya and Southdown breeds and was recognised by Karnataka as an improved breed in 1985. There is very little information pertaining to this breed and hence, this study was taken up to understand the breed and to evolve ways to improve the breed in future.

5.1 Sheep management practices

This breed of sheep is maintained on the organised farms of the University of Agricultural Sciences, Dharwad, Karnataka. The Housing and management practices are scientific and the record keeping is regular. This sheep is stationary in nature. The sheep are kept only on grazing and are watered two times a day. No supplementation of concentrates is given to the stock. The breeding, selection and culling of sheep is regularly done on these farms. The ram lambs required for breeding are selected on the basis of body weight at six months.

The housing and management of different breeds of sheep in India showed varied types of housing based on the needs of the sheep by the farmers according to the type of sheep like stationary and migratory (Jain *et al.*, 2005a, 2006a, Arora *et al.* 2007, Dixit *et al.*, 2005, Devendran *et al* 2009, Chandran *et al.*, 2009, Dayanand, 2013 and Shashikant, 2014).

5.2 Constitution of Sheep farms

The flock at Dharwad had 2 rams and 114 adult females while in Hanumanamatti farm the same were 14 and 27 in number. Dharwad had a rigorous culling in the recent past while Hanumanamatti is to take the action in near future. The total flock strength at Dharwad was 163 and that of H'matti was 67.

It was observed that there were 73 lambs on these farms with 27 males and 46 females. There were 37 females with 2 teeth, 62 with 4 teeth and 42 with 6 teeth and above.

5.2.1 Lambing pattern

The lambing pattern of UAS breed of sheep showed that the overall lambing percentage was 116.05 per cent.

Balasubramanyam (2012) in Madras Red and Mishra *et al* (2007) in Malpura sheep reported lower lambing percentage than the present study and Mishra *et al* (2007) reported similar lambing pattern of 106.66% in Garole X Malpura crossbreds. This indicated that the crossbreds tend to have better reproductive efficiency.

5.2.3 Sex ratio

The present study revealed that the overall sex ratio in UAS breed of sheep was 47.68 : 52.32. There was no significant difference between the births of males to females in the breed. Similar results were obtained by Govind Mohan *et al.* (2017) in Malpura flocks and Reddy and Naidu (2007) in Nellore sheep breeds.

5.2.4 Mortality in sheep

Except for the year 2017-18 the mortality in UAS sheep flock was low. That year saw an outbreak of HS in the district which resulted in the high mortality in Dharwad. The overall mortality observed was 11.9 and 7.80% in adult male and Females while the mortality in lambs was 11.60 and 9.50% in male and female respectively.

While most of the workers reported on pre and post weaning mortality in lambs, Ajay *et al.* (2007) reported an overall mortality rate of 12.60% in Muzaffarnagari and Govind Mohan *et al* (2017) reported 17.26% mortality in Malpura breed. The lower mortality in other years showed that the management practices on the farms were adequate and this breed has low mortality rate.

5.3 Performance of UAS lambs

5.3.1 Growth rate in UAS sheep lambs

The overall growth rate of lambs in this breed was 102.67 ± 3.84 gm and 82.47 ± 2.08 gm per day in males and females respectively. However, Basavaiah *et al.* (1994) reported a lower growth rate in UAS breed lambs maintained at Bidar (Table 2.6a). The studies by various workers in Ganjam, Balangir, Nilgiri, Mecheri and Madras red breeds revealed a lower growth rate than the present study (Table 2.6). This showed that crossbreds will have a higher growth rate compared to indigenous breeds. The study on Garole X Malpura half breeds growth rate was nearer to the present study. The reports on Hissardale, Bharat Merino and Avikalin showed a higher growth rate than the present study (Table 2.6a).

5.3.2 Body weight of lambs

The present study showed that the body weight of lambs at different ages were 3.40 ± 0.18 and 4.67 ± 0.89 kg at 0 – 15 day in male and females and increased to 18.50 ± 0.43 kg and 16.40 ± 0.51 kg up to 150 days. Hence, the males are ready for disposal by 180 days.

The body weight of male and female lambs at 3 months were 21.22 ± 0.29 kg and 19.50 ± 0.36 kg in Yalaga sheep (Dayanand, 2013) and 19.05 ± 0.15 kg in males and 16.76 ± 0.09 kg in females of Mouli lambs (Shashikant, 2014). These were higher than the present study. The differences could be due to lower number of animals in this study and the difference in the climatic conditions.

5.4 Biometric features of UAS breed of sheep:

Morphological traits reflect the body conditions of the animal and they are useful in characterising a breed. These are also useful in predicting the body weight of the animals under field conditions. Hence, the morphological study of both productive and non- productive traits were made.

5.4.1 Body Length

It was observed that the mean body length of males was 59.93 ± 3.23 cm and 58.40 ± 0.44 cm for females. The difference between different teeth stages was highly significant ($P < 0.01$). The average body length of various indigenous breeds by different workers showed longer body length than the UAS sheep except the ones reported for Rampur Bushair (Table 2.8.1). This indicated that UAS breed is being a crossbred and with wool on its body tends to grow smaller in size as compared to indigenous breeds.

5.4.2 Height at withers

The mean height at withers in males was 49.93 ± 3.18 cm and in females it was 54.58 ± 0.34 cm. The difference in height at withers at 2 teeth and 6 teeth stage was highly significant ($P < 0.01$). The indigenous breeds have higher height at withers than this breed as reported by various workers (Table 2.8.2 and Table 2.8.2a). The less acceptability of this breed among the farmers may be the reason that this breed is shorter than other breeds of Karnataka.

5.4.3. Back length

The average back length of UAS breed of sheep was 39.18 ± 1.16 cm and 42.92 ± 0.35 cm respectively in male and female adults. At 6 stage the back length was highly significantly longer ($P < 0.01$) than other stages. This indicated that this breed has a moderate back length.

5.4.4 Chest girth

The average chest girth of adults was 71.06 ± 1.79 cm and 73.06 ± 0.46 cm in males and females respectively. There was no significant difference in male and female chest girth. The difference between ages was highly significant ($P < 0.01$). The studies conducted on other Indian breeds by various workers (Table 2.8.3 and 2.8.3a) indicated that the chest girth of this breed is smaller than the other breeds.

5.4.5 Pouch girth

The overall mean pouch girth in UAS breed of sheep was 75.25 ± 1.41 cm in males and 77.48 ± 0.50 cm in females and the difference was highly significant

($P < 0.01$). The difference in chest girth at different teeth stages was also highly significant ($P < 0.01$).

Jain *et al* (2006a) reported a higher pouch girth than the present study in Kenguri sheep. The studies on Yalaga and Mouli breeds also revealed a higher pouch girth (Table 2.8.4).

5.4.6 Flank width

The overall mean of flank width of different age groups was found to be 11.75 ± 0.30 and 10.59 ± 0.08 cm, respectively in males and females and the difference between sexes and between age groups were not significant.

Dayanand (2013) in Yalaga sheep and Shashikant (2014) in Mouli sheep reported a higher flank width than the present study. This could be due to the fact that the two breeds are larger breeds of Karnataka.

5.4.7 Body weight

The overall average body weight of adult UAS sheep were 33.68 ± 2.82 kg in males and 29.87 ± 0.37 kg in females. It was found that there was no difference in body weight of both sexes and the body weights at different teeth stage were highly significant ($P < 0.01$). Most of the Indian breeds had higher body weight in both the sexes as reported by various workers (Table 2.8.6).

However, Rampur Bushair and Madras Red had similar body weight as UAS sheep and Hassan sheep had the lower adult body weight than UAS breed of sheep.

5.4.8 Measurement of non-productive traits of UAS breed of sheep

The average face length, distance between hip bones, distance between pin bones, hip to pin bones distance, tail length and ear length of adult Rams were 18.38 ± 0.45 , 9.68 ± 0.35 , 4.70 ± 0.30 , 4.68 ± 0.39 , 11.50 ± 0.35 and 13.25 ± 0.10 cm, respectively. The averages for females for the above characters were 17.30 ± 0.14 , 9.92 ± 0.09 , 6.3 ± 0.08 , 6.40 ± 0.14 , 11.70 ± 0.12 and 13.23 ± 0.08 cm, respectively.

Face length of UAS breed of sheep was similar to most of the southern Tamil Nadu breeds Ravimurgan *et al.* (2012). However, face length of Yalaga, Mouli and Vembur sheep were longer than UAS breed of sheep (Table 2.9a).

Ear length of UAS breed of sheep was similar to Bellary, Mandya, Ganjam and Coimbatore breeds (Table 2.9b).

The other breeds like Kenguri, Jailsalmeri, Muzaffarnagari and Mouli breeds have longer ears than UAS breed.

The UAS sheep had short tail length. Mandya, Coimbatore, Mecheri, Kenguri, Ramanad white and Vembor sheep have lower tail length than UAS sheep (Table 2.9c).

Munjral and Muzaffarnagari had much longer tail lengths and Jalauni, Jaisalmeri and Mouli had moderate tail lengths.

5.4.9 Comparison of two stations

It was observed that the sheep at two stations had highly significant ($P < 0.01$) different productive character measurements. However, the body weight of sheep did not differ significantly. The reason for such finding is due to the location of two stations in two agro-climatic zones.

5.5 Phenotypic correlation among different body measurements

The phenotypic correlations indicate the association among various characters, the correlations will give directions for the characters to be included for prediction equations. Hence, the phenotypic correlations among the characters were estimated for young ones and adults separately.

5.5.1 Ram lambs

It was observed that body weight had a very high correlation with body length, height at withers, back length, chest girth and pouch girth, hence, such characters which have high positive correlation with the body weight can be used for developing prediction equations in Ram lambs.

5.5.2 Ewe lambs

The correlations of various productive traits with body weight were very high. Hence, body length, height at withers, back length, chest girth and pouch girth can be used to estimate body weight of ewe lambs.

5.5.3 Ram

The correlation of body weight with chest girth and pouch girth were very high and that of body length, height at withers and back length were moderately high and positive.

5.5.3 Ewes

The correlations of different productive characters were medium to low in adult females. Chest girth and pouch girth had 0.64 and 0.66 correlations. This indicated that the predictability of body weight in ewes may be low.

Jain *et al.* (2017a and b) reported that overall correlation among various characters of Mouli and Yalaga sheep respectively, in Mouli sheep the correlations were positive and medium to high. In Yalaga sheep the correlations were positive and high to very high.

5.6 Prediction of body weight from body measurements

5.6.1 Ram lambs

It was observed that use of height at withers, body length and pouch girth gave an R^2 value of 95.80 per cent. However, use of height at withers alone explained 93.10 per cent variation in the body weights. Hence, the prediction equation $Y = -26.04 + 0.92 H$ was recommended for use in the field with a fairly good estimation of the body weights of ram lambs.

Jain *et al.* (2017a) developed prediction equations for estimation of body weights of ram lambs in Mouli breed with an R^2 value of 0.8479. The equation was $Y = 2.3457 X^{0.5139}$, where, Y = body weight and X = age of the animals in days.

Similarly Jain *et al.* (2017b) gave prediction equation for body weight in Yalaga sheep was $Y = 1.0663 X^{0.6288}$ with a R^2 value of 0.9574.

Since the age of the Ram lambs cannot be determined accurately under the field conditions, it would be difficult to use the equations for prediction of the body weight of Ram lambs. Hence, the equation developed for UAS breed of sheep will be more useful in the field conditions.

5.6.2 Ewe lambs

It was observed that the height at withers explained 91.40 per cent of the variation in body weights of ewe lambs. The equation of $Y = -16.55 + 0.66 H$ was recommended under field conditions. $Y = 2.0702 X^{0.5194}$ (R^2 0.9191) was prepared by Jain *et al.* (2017a) for Mouli female lambs and $Y = 2.007 X^{0.4554}$ (R^2 0.9415) was recommended by Jain *et al.* (2017b).

5.6.3 Rams

Prediction equations were developed using chest girth, body length. The R^2 value was found to be 97.71 per cent further analysis revealed that the equation of $Y = -52.07 + 1.21 G$ gave an accuracy of 89.42 per cent. This equation was recommended for estimation of body weight of Rams of UAS sheep.

Shashikant (2014) recommended $Y = 109.5 + 0.36 L + 1.05 H + 0.17 G + 1.27 F$ with R^2 value of 72.20 per cent. For Yalaga rams measuring many characters may be cumbersome chest girth in UAS rams it is sufficient to predict the body weight.

5.6.4 Ewes

It was observed that the predictability of body weight based on various measurements may not be quite accurate to predict the body weight of ewes. This was also observed when phenotypic correlations. The equation using pouch girth, body length, height at withers and chest girth gave an R^2 value of 46.14 per cent the best fitted equation of $Y = -7.69 + 0.40 P$ gave R^2 value of 43.05 per cent.

Shashikant (2014) proposed a prediction equation $Y = -40.82 + 0.274 L + 0.753 G$ ($R^2 = 61.38$) in Mouli sheep.

Suranagi and Biradar (2004) developed prediction equation of $Y = 0.6306 (L \times G) + 0.4435$ for predicting adult body weight of both sexes in UAS breed of sheep.

Ravimurgan *et al.* (2013) developed a prediction equation of $Y = -20.670 + 0.613 G$ for Kilakarsal sheep ($R^2 = 69.10\%$).

VI. SUMMARY AND CONCLUSION

Animal husbandry in India plays an important role in improving rural economy especially for the resource poor landless labours and other farmers. Sheep is an important small ruminant which was farm wasted and weeds. Karnataka has a sizable sheep population with 5 recognized and 3 lesser known sheep populations. UAS breed of sheep was released in 1985 by the government of Karnataka as an improved cross breed of sheep. It is a result of triple cross having the parentage of Deccani, Bannur and South Down breeds.

A study was taken with an objective of studying lambing pattern, sex ratio and mortality in UAS breed of sheep. Further the growth performance of lambs, morphological characters of UAS breeds were studied. The prediction equations to estimate the body weights were also developed.

The study was conducted on 230 animals from the organized farms of UAS Dharwad viz., Dharwad and Hanumanamatti (H'matti) of which 73 were lambs and others were adults.

The animals on both farms were maintained in well constructed houses with a facility to house various classes of sheep. Regular calling and selection processes were done. This sheep is stationary and maintained only on grazing.

The overall lambing pattern in UAS sheep was 116.05 per cent the sex ratio was 47.68 males : 52.32 females at birth, the overall mortality for lambs was 11.60 and 9.50 per cent in male and female lambs. Similarly, 11.90 and 7.80 per cent mortality was observed in adult male and females, respectively.

The young ones in this sheep had 102.67 ± 3.87 g and 82.47 ± 2.08 g per day growth rate in males and females, respectively. At 0-15 days age male and female lambs weighed 3.40 ± 0.18 and 4.67 ± 0.89 kg, respectively up to 150 days. The males and females weight 18.50 ± 0.43 kg and 16.40 ± 0.51 kg, respectively indicating that the male lambs are at marketable weight at 6 months of age.

The overall body length in adult males was 59.93 ± 3.23 and in females 5.84 ± 0.44 cm, respectively. The difference in body length at different stages was highly significant ($P < 0.01$).

The height at withers was 49.93 ± 3.18 cm and 54.58 ± 0.34 , cm in males and females, respectively and the difference between the ages was highly significant ($P < 0.01$).

The average back length of male and females was 39.18 ± 1.16 and 42.92 ± 0.35 cm, respectively and the difference in the different age group was highly significant.

The overall means for chest girth and pouch girth for males were 71.06 ± 1.79 and 75.25 ± 1.41 cm, respectively. The average for females were 73.06 ± 0.46 and 77.48 ± 0.50 cm, respectively. Both the characters differed highly significantly ($P < 0.01$) between the ages.

The average body weight adult males was 33.687 ± 2.82 kg and 29.87 ± 0.37 kg, respectively. The differences in the body weight among the ages was highly significant ($P < 0.01$).

The average face length, distance between hip bones, distance between pin bones, hip to pin bones distance, tail length and ear length of adult Rams were 18.38 ± 0.45 , 9.68 ± 0.35 , 4.70 ± 0.30 , 4.68 ± 0.39 , 11.50 ± 0.35 and 13.25 ± 0.10 cm, respectively. The averages for females for the above characters were 17.30 ± 0.14 , 9.92 ± 0.09 , 6.3 ± 0.08 , 6.40 ± 0.14 , 11.70 ± 0.12 and 13.23 ± 0.08 cm, respectively.

The phenotypic correlations in Ram lambs and ewe lambs for body length, height at withers, back length, chest girth and pouch girth with body weight were very high. The correlation of body weight with chest girth and pouch girth were very high and body length, height at withers, back length were moderately high and positive in Ram lambs. In case of ewes the productive characters had medium correlation with body weight.

Prediction equations were developed for estimating the body weight of lambs and adults. Following prediction equations were recommended for use under field conditions

i) Ram lambs $Y = -26.04 + 0.92 H$ ($R^2 = 93.10\%$)

ii) Ews lambs $Y = -16.55 + 0.66 H$ ($R^2 = 91.40\%$)

iii) Rams $Y = -52.07 + 1.21 G$ ($R^2 = 89.42\%$)

iv) Ewes $Y = -7.69 + 0.40 P$ ($R^2 = 43.05\%$)

Where,

Y = body weight (kg), H = height at withers (cm), G = chest growth (cm) and
 P = pouch girth (cm)

It is concluded that the initial growth of young ones is not sustained and reflected in the adult stock concreted efforts need to be made to achieve higher body weight in adults. Supplementation of concentrations may help in achieving this. The Ram lambs are selected only on body weight at six month age for breeding purpose.

There is a need to select breeding Rams height at withers and body length. Because of the lower height and back length of this breed, the popularity of this breed among the farmers is low. Hence, there is a need to intensity the extension activities in order to popularize the breed. The author found that the flock strength of this breed is small. There is a need to have more organized flocks across the state of Karnataka, so that the population size will increase and subsequently break the inbreeding effects, by following exchange of rams among the farms. This breed has tender and Juicy mutton with excellent flavor. This could be further exploited.

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