PERFORMANCE OF SHEEP AND GOAT IN SEMI-ARID REGION UNDER FREE RANGE GRAZING MANAGEMENT

A THESIS
PRESENTED TO THE
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY
IN
ANIMAL PRODUCTION AND MANAGEMENT

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February, 1984

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CERTIFICATE

This is to certify that the work recorded in this thesis entitled "Performance of sheep and goat in semi-arid region under free range grazing management" submitted by Narendranath Swain for the degree of Doctorate of Philosophy in Animal Production and Management of the Bidhan Chandra Krishi Viswa Vidyalaya, is the faithful and bonafied research work carried out under our personal supervision and guidance. The results of the investigation reported in the thesis has not been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.

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A C K N O W L E D G E M E N T S

It is a pleasure and unique opertunity on my part to express my sincere appreciation and deep indebtedness to my advisors, Dr.D.N.Maitra, B.Sc., B.V.Sc., M.Sc.(A.H.), Ph.D., Head, Department of Animal Production and Management, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, (W.B.) and Dr. Manohar Singh, B.Sc.,M.V.Sc., Ph.D., Head, Division of Animal Nutrition and G.F.A., Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) for their valuable guidance and encouragement throughout the entire period of this study. The whole hearted co-operation, sound suggestions and constructive criticism which rendered to complete this manuscript is gratefully acknowledged.

I am grateful to Dr. R.Nagarcenkar,Ph.D., the Director of Central Sheep and Wool Research Institute, Avikanagar for necessary facilities to carryout the work.

I am also grateful to Dr. R.M.Acharya, Ph.D.,Deputy Director General (Animal Sciences),ICAR, New Delhi for his help and valuable suggestions to carryout this work.

I gratefully acknowledge the co-operations of Drs. C.L. Arora, A.K.Basuthakur, K.L.Sahni, P.B.Mathur, A.K.Rai, D.R.Bhatia, P.M.Jain, M.M.Sharma, S.S.Lahri, Dhirendra Singh of the Central Sheep and Wool Research Institute, Avikanagar and Dr. S.Majumdar and S.Roy of Deptt. of Animal Production & Management, B.C.K.V.V., Mohanpur for their help at various stages of this work.

The assistance rendered by Mr. D.L.Verma, M.Asgar, R.B. Parekh, L.S.Rawat, T.R.Suman, P.K.Pradhan, P.S.S.Rao, S.Banik, Staff members of Nutrition Deptt., CSWRI, Avikanagar, and Staff members of DFAB, Garsa is also gratefully acknowledged.

I express my profound sence of gratitude to my parents and in-laws for their blessings and appreciate the love and affection of my wife, daughter and son without which it would have been impossible to complete the work.

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Dated, the,
23rd Feb., 1984.

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CHAPTER - I

I N T R O D U C T I O N

INTRODUCTION

Both sheep and goat thrive well in tropical climate and substantially contribute to the basic economy of the country providing wool, meat, milk and skin directly for human use and indirectly by increasing soil fertility of unproductive land distributing manure and urine while grazing and through folding. These two species are more important in arid, semi-arid and mountaneous regions where crop farming are not economically feasible due to scanty surface as well as under ground water resources, sandy and unfertile soil, poor water holding capacity and scarcity of ample plain and fertile lands.

Mostly, the sheep and goat are maintained together as a single flock by landless labourers and marginal farmers and are to undergo long mi-gration and live on poor and scanty vegetation under harsh environmental and poor hygenic condition. As per 1977 livestock census India had 68 million goats and 40 million sheep, contributing 255 million kg. of chevon, 890 million kg. milk, 34.9 million pieces of skin and 101 million kg. wool and 14.6 million pieces of skin, respectively.

The goats were reported more profitable than sheep by Abid (1970), Cook (1970), Acharya and Patnayak (1974), Wahid (1975), Devendra (1978), Ghosh and Khan (1981) and Swain et al. (1982b). The profitability was mainly due to their higher feed efficiency and digestibility of crude fiber which was reported by Mia et al.

(1960), Jang and Majumdar (1962), Gallag and Shelton (1972), Devendra (1975), Gihad (1976), Hog (1976), and Sharma and Rajora (1977) and better adaptability with higher fecundity and lower mortality as reported by Swain et al. (1982 b).

Raleigh and Lesperance (1972) has reported that about 40% of land surface is under range with vegetation extremely heterogenous in nature and this could be best utilized by sheep and goat, with major emphasis in soil conservation and desert development programmes to revegetate highly degraded range lands through conservation of available vegetations and further reseeding with locally adopted and nutritious grasses, legumes and plantation of fodder cum fuel trees and shrubs.

Our knowledge on relative performance of native and crossbred graded sheep and goat under natural land condition managed either in the manner the sheep farmer usually manages his sheep or better management system is inadequate.

In the present study the performance of sheep and goat in semi-arid region under free grazing/browsing on degraded range land was undertaken with the following objectives:

1) Compare the production potential of native (Malpura) sheep with their half-breds (with Rambouillet F_1s)
2) Compare the production performance of native (Sirohi) goat with their half-breds (with Beetal F_1s) as well as with the native and cross-bred sheep.

3) Study the nutritional status of these two species during different periods of the year.

4) Study the influence of physical environment on animal performance.

5) Study the relative economics of sheep <u>Vs</u>. goat under free range grazing/browsing with necessary health and managemental inputs.

This study was expected to yield informations of the following practical utility:

a) Production remuneration management of sheep and goat in natural range land is expected to provide practical informations on relative economics of these two species and reproductive performance, since, human interferance in conventional managemental system in most of the organised farms influences the progress.

b) Success of this type of farming will serve as a model for interested small/marginal farmers and attract them towards livestock enterprizes due to immediate return without much investment and attaining self sufficiency within a few years.

c) Success of this farming will attract agencies to switchover from the conventional livestock managemental practices which involves lot of man power, labour unrest, expenditure on infrastructure, feed/fodder and experimentation/management through non-committed regular workers under uncertainity of success as well as return of initial investment.

d) Nutritional status of animals will provide informations on stocking rate, period and quantity of supplementary feeding as well as the future plan of improving range land either through conservation of natural pasture/cultivation of cereal or leguminous fodder or plantation of fodder trees as deemed fit for the agroclimatic condition to meet the demand of the livestock for better production.

e) Information on the influence of physical environment on animal performance will indicate the type of animals best suited to a particular geographic/agroclimatic condition.

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Range land:

The range land was defined by Sampson (1952) as large, naturally vegetated, mostly unfenced and of low rainfall areas, mostly grazed by domestic and game animals. Raleigh and Lesperance (1972) reported that the range land comprises more than 40% of earths land and extremely heterogenous in nature, soil type, altitude and topography.

Vegetational survey:

Vegetational survey of ground and top feed resources are generally conducted to give a picture of a particular land in terms of percent cover, botanical composition and yield per unit area. The various methods for studying ground vegetation suggested are the line-intercept by Canfield (1941), quadrat count, pantographic charting, point quadrat by Saxena (1974) and square foot density by Stewart and Hutchings (1936). For the survey of top feed resources with respect to distribution of trees, the stock maping and strip survey was suggested by Bhimaya and Ahuja (1968).

Estimation of physical envirohment:

Ambient temperature, relative humidity, solar radiation and wind velocity are the principal factors determine the physical environment affecting to the livestock directly or indirectly.

Several indices like "effective temperature"(ET), "temperature humidity index" (THI) by Mc Dowell (1972a) and "temperature humidity sunshine" (THSI) by Thomas and Acharya(1981) have been developed for estimating the combined effect of different physical and environmental elements on animals.

These methods of measurement have their own limitations.

The index "effective temperature" includes solar radiation in addition to ambient temperature and humidity. Measurement of solar radiation requires sophisticated equipments and it is usually not recorded in most of the meteorological stations.

The "temperature humidity index" do not take in to account the diurnal variation in ambient temperature and humidity and effect of solar radiation. Both diurnal variation and solar radiation, the latter more exactly expressed in terms of hours of light are especially important for hot semi-arid regions. Hence, indices which do not take in to account of these factors will be less applicable to express the total effect of physical environment on the animals, where as, incorporation of hours of day light with temperature and humidity could give good index of the effect of physical environment on the animals.

Hence, the "temperature humidity sunshine index" as reported by Thomas and Acharya (1981) for cattle was used in this study.

Grazing behaviour with reference to distance travel :

Distance travel by the grazing animal has important bearing on the various productive performance of the stock. From time to time various methods have been suggested to account the distance covered by the grazing animals. Cory (1927) estimated the distance travelled by the animal by counting the number of steps of known length. Cresswell (1957) used range meter, Dwyer (1961) observed the animal and mapped its movement, whereas Powell (1968) and Anderson and Kothmann (1977) used the Pedometer.

It was reported by Powell (1968) that in temperate areas the hours of day light were positively related to the distance walked by sheep in natural range land. Wind velocity in the cold desert range was reported to be highly and inversely related to the distance walked by grazing cattle by Malechek and Smith (1976). Anderson and Kothmann (1977) had reported that the location of water as well as the wetness of forage influences the distance travelled by grazing animals. Alexander and Williams (1973) have observed that in dry areas with ambient temperature above 40°C, the goats can move 10 km but for sheep 5 km was near the maximum. Lofgreen et al.(1957), Arnold (1960 b) and Anderson and Kothmann (1977) had reported that as forage availability decreased, the animals spent more time on grazing and thus walked more in range land.

In addition to these conditions of ambient temperature, location of water and topography, the size of range land also influences the walking distance. Terrill (1968) had observed that sheep in small pasture walk 1.5 - 3.5 km/day and in unfenced range upto 11 km/day.

Some of the observation with respect to distance travel have been tabulated below in table 2.1.

Table 2.1: Distance travel by sheep and goat/day

Sl.No.	Travel distance	Species	Condition	Reference
1.	5.0 km	Sheep	Dry area having temperature above 40°C	Alexander and Williams(1973)
2.	5.0-10.0miles	-do-	Under range	Cresswell(1960)
3.	2.0- 3.0 miles	-do-	Under range	Tribe(1949)
4.	3.8 miles	-do-	Under range	Cor y(1927)
5.	11.0 km	-do-	In unfenced range	Terrill(1968)
6.	1.5 miles	-do-	Small paddocks of size 1-2 acres	England(1954)
7.	4.0 miles	-do-	Paddock of 800 acres	Cory(1927)
8.	10.0 km	Goat	Dry area having temperature above 40°C	Alexander & Williams(1973)
9.	6.0 miles	-do-	Under range	Cory(1927)

Growth rate of lambs and Kids:

The observations on birth weight and growth at subsequent stages among different breed/breed-crosses of sheep and goat have been tabulated below in Table 2.2.

Table 2.2: Birth and growth rates of lambs and kids

Breed/Breed cross	Species	Growth rate (kg)				Reference
		Birth	Weaning	Six month	One year	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mandya	Sheep	2.05	8.50	11.76	18.57	Arora and Acharya (1976)
Marwari	-do-	2.64	-	-	19.55	Sahni et al.(1980)
Marwari x Avikalin	-do-	2.84	-	-	20.57	- do -
Chokla	-do-	2.37	11.13	13.46	17.89	Acharya (1982a)
Magra	-do-	2.98	11.70	20.14	27.99	- do -
Nali	-do-	2.88	10.19	13.30	17.74	- do -
Sonadi	-do-	2.40	9.29	13.22	18.95	-do -
Muzaffarinagri	- do-	3.01	10.76	14.56	25.01	- do -
Patanwadi	-do-	2.99	13.68	-	21.90	- do -
Malpura (Range grazing)	-do-	2.65	8.64	12.52	13.75	Acharya et al. (1980)
Bikaneri	-do-	3.20	12.10	17.60	31.90	Bhat and Bhat(1981)
Lohi	-do-	2.80	11.00	14.30	19.60	- do -
Decani	-do-	2.80	10.80	11.80	12.90	- do -
Banur	-do-	1.90	8.10	15.00	16.50	- do -
Ramand	-do-	-	9.70	-	16.00	- do -

(Contd...10)

Table 2.2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nellore	Sheep	2.40	9.50	-	18.70	Bhat and Bhat (1981)
Rampur Bushair	-do-	3.40	-	17.30	-	- do -
Avikalin	-do-	3.25	15.95	21.37	29.80	Annual Report CSWRI,Avikana-gar (1976)
Sirohi	Goat	2.82	9.92	13.48	21.47	Acharya(1982a)
Barbari	-do-	1.74	6.66	7.80	14.52	- do -
Jamunapari	-do-	4.27	12.11	15.56	29.65	- do -
Beetal	-do-	2.80	9.26	12.18	21.83	- do -
Marwari	-do-	2.29	6.00	8.70	16.25	- do -
Sanen	-do-	2.71	-	-	-	Singh _et al_. (1977)
Black bengal	-do-	1.0-1.1	4.3-4.8	6.0-6.7	8.1-11.8	Khan and Bhat (1981)
Malabari	-do-	1.7-1.9	5.4-5.5	7.8-8.5	11.3-18.2	- do -
Native Malpura (non descriptive)	-do-	2.92	9.27	13.63	21.67	Acharya _et al_. (1980)
Sirohi x Beetal	-do-	3.02	11.33	13.79	19.25	Annual Report AICRP,Goat CSWRI (1981)

Hafez (1962) reported that the males were heavier than females at birth. He attributed that the males were under the influence of male sex hormones secreted by the gonads. This hormone has an anabolic effect resulting into faster growth during pre-natal development.

Epstein and Herz (1964) reported that the body weight of females kids were 6.3% less than the males at birth. The cross-breeding was reported to produce lambs of higher body weight at birth by Sahni *et al.*(1980) and kids by Iqbalnath and Chawla (1978), respectively.

Factors affect pre-weaning gain:

The pre-weaning gain of offspring is influenced by year and season of birth, sex, birth weight, breed and amount of milk consumed. Twombly *et al.* (1961) and Sidwell *et al.*(1964) reported difference as high as 12.5 and 7.5 kg, respectively between years in the weaning weights of columbia - Rambouillet ewes; Hampshire, Shropehires, Southdown and Merino breeds and their crosses. Eltawil *et al.*(1970) found the contribution of year effect in the variation of weaning weight to be 22.18 to 26.76 percent in Navajo ewes. Acharya *et al.*(1973) reported significant ($P < 0.01$) influence of bred on weaning wêight among Nali, Nellore x Nali, Nellore x Lohi and Mandya x Lohi (F1 and F2) sheep. They have also reported significant ($P < 0.01$) influence of month of birth on weaning weight, which may be due to the difference in availability of grazing conditions and fodder and weather conditions affecting the general comfort of the ewe and lambs and ewe's milk yield. The sex of lamb ($P < 0.05$) and ewe's weight at lambing ($P < 0.01$) and season was also reported to influence the pre-weaning gains among the above breed groups. The lambs born during February-March was reported heavier than those born in September and October, which may be partly due to difference in the birth weight and partly due to weather condition. The influence of birth weight on pre-weaning gain was also observed by De Baca et al.(1956) , Ray and Smith (1966) and Eltawil et al.(1970) and for every kg increase in birth weight there was an increase of 5.95, 5.65 and 2.45 kg in weaning weight of crossbred, mixed range lambs and Navajo lambs, respectively. The milk yield of sheep was also reported to influence the pre-weaning gain. Acharya and Bawa (1971) while studying the milk yield of Nali and Lohi sheep indicated highly significant ($P \angle 0.01$) correlation between pre-weaning gain and ewe's milk yield, which is a function of her size, and the nutritional and climatic conditions in which she performs her lactation. Robinson et al.(1969) had reported a linear relationship between the milk consumption and body weight gain of lambs having a co-rrelation value of 0.87.

Changes in adult body weight:

The body weight changes of adult dry animals recorded at monthly intervals by Acharya et al.(1980) indicated that the native Sirohi goats exhibited decline in body weights from February to July followed by an increase during rest of the period except for a major decline in October. The Malpura sheep lost their body weight from January to July followed by an increase upto December. They explained that, the changes in body weight of both sheep and goat closely followed the seasonal fluctuations in vegetation resources. With the cesation of monsoon, the surface vegetation continued to decline till the new growth appeared in June-July. Thus, the surface vegetation resource become scare with the advance of time from January through June, resulting into lower body weights of the animals. From July to December surface and top feed resources were availablle in plenty, and thus reflected in higher body weights during this period.

Influence of physical environment on body weight changes:

The influence of physical environment in terms of minimum and maximum temperature and relative humidity on body weight changes of Sirohi goats and Malpura sheep during different months was studied by Acharya et al.(1980). It was reported that the sheep were affected more adversely by both minimum and maximum temperature while goats were not affected at all. The relative humidity had no effect on adult body weight changes of neither sheep nor goat.

Lactational performances:

Lactation length and Lactation yield:

The lactation length and lactation yield of different breed/ breed-crosses of goats has been tabulated below in table 2.3.

Lactation curve:

The milk yield among Sirohi and Sirohi x Beetal ½ goats maintained under semi-arid agroclimatic condition of Rajasthan was reported to reach peak between third and fourth week (Av.3.3 week)

Table 2.3: Lactation length and lactation yield of different breed/breed-crosses of goats

Breed/Breed cross of goats	Age group (Years)	Av.Lact. yield(kg)	Av.Lact. length(days)	Reference
Jamunapari	-	201.96	191.0	Acharya(1982a)
Barbari	-	107.12	150.13	- do -
Sirohi	-	71.18	174.8	- do -
Beetal	All Lact.	177.38	187.0	- do -
Jhakrana	-	121.80	114.7	- do -
Mehsana	-	1.32kg/day	197.2	- do -
Beetal	-	-	205.5	Mehla and Mishra (1980)
Alpine x Beetal	-	-	228.4	- do -
Saanen x Beetal	-	-	243.2	- do -
Jamunapari	-	211-272	210-287	Khan and Bhat (1981)
Black Bengal	-	36-58	119-122	- do -
Malabari	-	39-151	123-140	- do -
Beetal x Sirohi	-	80.43	190.94	Annual Report, AICRP Goat, CSWRI(1981)
Sirohi (Range grazing)	-	53.34	152	Acharya *et al.* (1980)
Beetal	First Lact.	130.08	-	Singh & Acharya (1980)
- do -	3rd Lact.	211.74	172.7	- do -

and between second and third week (Av. 2.89 week) of post kidding, respectively in the Annual report, AICRP, goat, CSWRI, (1981). The average milk yield among Sirohi was 0.468 and in Sirohi x Beetal was 0.472 kg/day, respectively. The peak yield among the above breed/ breed crosses was 0.912 and 1.03 kg/day , respectively.

Greasy fleece yield:

The greasy fleece yield from adult sheep shorn at six monthly intervals and from lambs at the age of six month has been tabulated below in table 2.4 and 2.5 respectively.

Table 2.4: Greasy fleece yield from adult sheep at six monthly interval

Breed/breed cross	Six monthly greasy fleece yield(kg)	Reference
(1)	(2)	(3)
Chokla	1.37	Acharya (1982a)
Nali	1.46	- do -
Magra	1.09	- do -
Marwari	0.89	- do -
Sonadi	0.45	- do -
Jaisalmeri	0.77	- do -
Pugal	0.80	- do -
Patanwari	0.63	- do -
Lohi	0.77	Bhat and Bhat (1981)
Decani	0.74	- do -

(contd..)

Table 2.4 (contd.)

(1)	(2)	(3)
Muzaffarinagri	0.64	Bhat and Bhat (1981)
Avikalin	1.07	Annual Report,CSWRI(1976)
Marwari	0.55	Sahni et al. (1980)
Marwari & Avikalin	0.69-0.76	- do -
Malpura (range grazing)	0.55	Acharya et al.(1980)
Nali	1.41	AICRP,S.B.(1981)
Chokla	1.32	- do -
Gaddi	0.45	- do -
Malpura	0.537	- do -
Dorset,Suffolk x Malpura, Sonadi	0.499	- do -

Table 2.5: Greasy fleece yield from lambs at six months of age

Breed/breed cross	First six monthly greasy fleece yield (kg)	Reference
Malpura	0.427 ± 0.021 (31)	Acharya et al.(1980)
Nali	0.953 ± 0.368 (341)	AICRP,S.B.(1981)
Chokla	0.897 ± 0.016 (439)	- do -
Nilgiri	0.472 ± 0.079 (111)	- do -
Malpura	0.544 ± 0.031 (63)	- do -
Sonadi	0.526 ± 0.009 (39)	- do -
Dorset,Suffolk x Malpura, Sonadi	0.759 ± 0.01 (1281)	- do -
Avikalin(Malpura x Rambouillet ½)	1.038 ± 0.035 (97)	- do -

Influence of physical environment on greasy fleece yield:

Temperature:

The air temperature was reported to be negatively co-rrelated with wool production of Bikaneri ewes by Nagarcenkar and Bhattacharya (1964a) and the variation in wool production due to air temperature was - to the extent of 50.8%. Negative co-rrelation between wool production and atmospheric temperature was also reported by Findlay (1954), Findlay and Beakley (1954) and Maule (1956).

Relative humidity:

Daly and Carter (1955) while working with the fleece growth of young Lincoln, Corriedale, Polworth and fine Merino maiden ewes under housed conditions and unrestricted and progressively restricted feeding on a standard diet, reported that the relative humidity alone had no influence on wool yield. Nagarcenkar and Bhattacharya (1964 a) with Bikaneri ewes has also reported that the atmospheric humidity alone has no influence on wool yield.

Photoperiod:

The influence of different photop eriod on wool production with Bikaneri ewes was studied by Nagarcenkar and Bhattacharya (1964 b). The control animals were housed in thatched shed and were exposed to all rigorous weather conditions and other groups were provided with 1:2 light/dark and 2:1 light darkness. The wool production among experimental animals was increased significantly. The light was reported to stimulate pituitary, resulting higher wool production, but intense shedding of wool fiber was however observed in the groups subjected to higher photoperiod, and hence the actual wool yield get reduced in the animals receiving larger photoperiod for a prolonged period, with the conclusion of negative and linear correlation of wool production with day length. It was also reported that 44.49% variation in wool production was due to the day length.

Interaction between relative humidity, temperature and photoperiod:

The shedding of wool was reported by Nagarcenkar and Bhattacharya (1964 c) due to the result of interaction between prolonged photoperiod, temperature and humidity which depressed the thyroid activity and increase adrenal gland secretion which inhibits the wool growth and fibers thus get detached and slaughoff.

Influence of cross-breeding on greasy fleece yield:

The cross-bred sheep was reported to produce more greasy fleece than the natives by various workers. Acharya and Arora (1972) reported that the F_1 produced as a result of cross-breeding between native Malpura with exotic Rambouillet produce 67% more greasy fleece than the natives. Higher greasy fleece yield among cross-bred was also reported by Knot et al.(1962), Ramamurthy (1964), Amble and Malhotra (1966), Singh and Tyagi (1969), Raina et al.(1973 a), Gopalan and Marutiram (1974), Acharya(1974) and Mani Mohan (1977).

Age at first kidding/lambing and kidding/lambing interval:

The age at first kidding/lambing and the kidding/lambing interval in different breed/breed-cross of sheep and goat has been presented in table 2.6 and 2.7, respectively.

In general it was observed by Kumar et al.(1980), Mehla and Mishra (1980) that the cross-bred goats had the lower age at first kidding compared to their corresponding natives, and the differences were 80 days in Beetal x Alpine crosses, and 71 days in Beetal x Sannen crosses, respectively. It was also reported by Longrigg (1961), Hulet et al.(1969) and Laster et al.(1972) that the ewes/does bred first as lambs/kids had a higher life time production rate than those bred as yearlings and there by significantly increase profit in the livestock industry.

Trupping frequency:

The non seasonality in breeding of goats has been reported by Amble et al.(1964), Pant (1979), Devendra (1962),Devendra and Burns (1970), Rajkonwar and Borgohain (1978), Sing and Sengar(1978). The non seasonality in breeding activity among sheep has also been reported by Hafez (1953), Taneja (1966), Sahni and Roy (1967). It was reported by Tyagi and Lavania (1968) that about 80% of sheep bred during June and October.

Among the native does of Bihar the tupping frequency was reported highest during October (20.86%) followed by September

Table 2.6: Age at first kidding/lambing

Breed/Breed cross	Species	Age at first kidding/lambing	Reference
Beetal	Goat	679 days	Bhatnagar,*et al*.(1975)
Beetal	"	776.09±5.26 days	Singh and Acharya(1980)
Beetal	"	107 weeks	Prakash *et al*. (1971)
Beetal	"	77.87 weeks	Khatter and Mishra(1977)
Barbari	"	21.6 months	Dutt (1968)
Black Bengal	"	15.27±1.76 months (216)	Rahman *et al*.(1977)
Beetal x Sirohi	"	741±19 days (49)	Annual Report,AICRP,Goat, CSWRI (1981)
Jamunapari	"	25.08-25.13 months	Singh and Singh (1974)
Native Malpura	"	564±42 days (10)	Acharya, *et al*.(1980)
Sirohi	"	767±21 days	Annual report,AICRP,Goat, CSWRI (1981)
French Alpine	"	25.4 months	Gill and Dev (1972)
Alpine	"	20.0 months	- do -
Alpine	"	467 days	Bhatnagar *et al*.(1975)
Alpine	"	598 days	Kumar *et al*.(1980)
Alpine	"	79.53 weeks	Khatter and Mishra(1977)
Anglo nubian	"	25 months	Gill and Dev (1972)
Beetal x Alpine	"	497 days	Bhatnagar *et al*.(1975)
Beetal x Alpine	"	71.54 weeks	Khatter and Mishra (1977)
Beetal x Alpine	"	520 days	Kumar *et al*.(1980)
Beetal	"	600 days	- do -
Malpura	Sheep	854	Acharya *et al*.(1980)
Avikalin	"	819±20(204)	Annual report,CSWRI(1978)
Avivastrn	"	852±21(157)	Annual report,CSWRI(1978)
Very fine wool(GA)	"	1009±38(54)	Annual report,CSWRI(1978)

Table 2.7: Kidding/Lambing interval

Breed/breed cross	Species	Kidding/ lambing interval	Reference
Black Bengal	Goat	7.46 ± 1.23 months (216)	Rahman *et al.* (1977)
Beetal	"	334.12±10.91 to 381.64±3.14	Singh and Acharya(1980)
Native Malpura (Non descriptive)	"	329± 17 days (41)	Acharya *et al.*(1980)
Sirohi	"	359 ± 21 days (52)	Annual report,AICRP, Goat,CSWRI(1981)
Sirohi x Beetal	"	405 ± 25 days (36)	- do -
Malpura	Sheep	432 ± 32 days	Acharya,*et al.*(1980)

(13.4%, July (11.68%), November (11.18%), June (10.14%), August (8.16%), December (7.07%), January (4.74%), May (4.44%), April(3.18%), February (2.8%) and March (2.23%) by Singh *et al.*(1978).

Factors associated with tupping frequency:

Yeates (1949) reported that the on set of reproductive activity of sheep and goat was engendered by a light sensitive retinopituitary mechanism. Prasad (1954), Fraser and Laing (1969), Ducker and Bowman (1970 a,b), Ducker *et al.*(1970 a,b) Newton and Betts (1972) and Schanbacker (1980) have reported that under natural condition both sheep and goat tend to come in sexual activity when the days become shorter.

Although the evidence indicated that light is a factor in regulating the incidence of oestrus, the possibilities exists that the other environmental factors may also share some responsibility in regulating the oestrus. The environmental temperature which is closely associated with the changes in light under natural condition, suggests itself as one of the factor of importance in this respect. However, there is no information in the combined effect of various climatic factors on the sexual activity of sheep and goats.

Kidding and lambing frequency:

The kidding and lambing frequency of native Malpura does and Malpura Sheep managed under natural degraded range land over a period of 3 years was studied by Acharya *et al.*(1980). The kidding was reported to occur throughout the year with the maximum kidding during November (31.58%), followed by May (14.44%), December(13.14%) and October (9.19%). The lambing was also reported to spread round the year except for June and September. The maximum lambing was reported during December (35.82%), followed by January (20.86%) and November (8.95%).

Chowla *et al.*(1980) reported the incidence of more than 75% kidding was between November to March.

Kidding and Lambing performance:

The observations on kidding and lambing performances with respect to kidding/lambing percent and number of progeny per 100 animal has been presented below in table 2.8.

Mortality of sheep and goat:

With increase inheritance of exotic blood for better productivity of our indigenous breeds for milk meat and fiber in goats and

Table 2.8: Kidding and lambing percentage

Breed/Breed crosses	Species	Lambing %	Basis of calculation	No.of Progeny/ 100 animal	Reference
Malpura	Sheep	55.62	No.of ewes tubbed	-	Annual report CSWRI(1978)
Sonadi	"	63.70	No.of ewes tubbed	-	- do -
Avikalin	"	70.79	No.of ewes tubbed	-	- do -
Avivaston	"	66.39	No.of ewes tubbed	-	- do -
Malpura(under range)	"	82.48 $\pm$ 14.12	No.of ewes available	82.48 $\pm$ 14.12	Acharya *et al.* (1980)
Sirohi x Beetal	Goat	71.55	No.of ewes tubbed	-	Annual report, CSWRI(1978)
Sirohi(range grazing)	"	84.193 $\pm$ 9.629	No.of ewes available	91.936 $\pm$ 9.71	Acharya *et al.* (1980)

meat, wool and pelt in sheep, there is a higher tendency of mortality and morbidity due to tropical and sub-tropical heat, especially coupled with high humidity, conductive for breeding and survival of insects, ticks and other vectors which transmits infections. These are further enhanced with high density of animals per unit grazing area, poor grazing/browsing resources, very little supplementation with nutritious, cultivated fodders or concentrate feeds, little possibility of grazing management which will help preventing/reducing chances of re-infection, especially for gastro-intentinal parasites, resulting in increase pre-disposition of sheep and goats to a number of diseases. Under organised farm conditions, restricted grazing hours, that too during uncomfortable period of the day, confinement of animals in enclosures in high density, further adds to nutritional, physical and environmental stress resulting into high morbidity/mortality, there by increasing expenditure through preventive, curative measures and supplementary feeding. However, in general the morbidity and mortality in goats are much less compared to sheep, due to their difference in grazing habbit and better adaptability to various adverse conditions.

Studies conducted at different organised farms revealed the mortality of sheep and goats as below in table 2.9 and 2.10 and the causes of mortality in table 2.11 and 2.12,respectively.

Table 2.9 : Mortality in sheep (%)

Place	Breed	0-3 months	0-6 months	3-12 months	Adults	Reference
CSWRI Avikanagar	Nali	18.93	-	20.20	10.76	Acharya(1982)
CSWRI, Avikanagar	Malpura (range grazing)	16.39	56.66	-	31.25	Acharya *et al.* (1980)
Sikim	Gaddi	10.60	-	11.11	9.50	AICRP, S.B. (1981)
Sikim	Ramb. x Gaddi	22.43	-	11.98	7.37	- do -
Sikim	Merino x Gaddi	18.48	-	20.59	7.77	- do -
CSWRI, Avikanagar	Malpura	16.00	-	12.00	34.00	- do -
CSWRI, Avikanagar	Sonadi	21.00	-	12.00	36.00	- do -
CSWRI, Avikanagar	Avikalin	15.00	-	1.37	13.65	Annual report, CSWRI(1976)

Table 2.10 : Mortality in goats (%)

Place	Breed	0 - 3	3 - 6 (Age group	6 - 12 months)	3 - 12	Adult	Reference
CSWRI, Avikanagar	Sirohi	1.47	0.93	1.83	-	2.31	Annual report,AICRP, Goat,CSWRI (1981)
- do -	Beetal x Sirohi, F1	2.76	2.27	1.49	-	3.12	- do -
- do -	- do - F2	2.02	3.57	1.04	-	-	- do -
- do -	3/4th Beetal	1.70	1.59	1.74	-	2.79	- do -
B.R.College Agra(P.L.480 Project)	Jamunapari	45.50	-	-	55.56	16.10	Acharya (1982 b)
- do -	Beetal	37.60	-	-	39.60	20.80	- do -
- do -	Barbari	38.90	-	-	38.20	18.00	- do -
- do -	Black Bengal	48.10	-	-	34.50	16.80	- do -
- do -	Sirohi	1.90	-	-	4.00	2.50	- do -
-	Marwari	-	-	-	-	9.60	- do -
-	Beetal	25.40	-	-	-	13.20	- do -
-	Barbari	41.50	-	-	-	-	- do -
-	Gaddi	2.17	-	-	1.20	22.30	- do -

Table 2.11: Causes of sheep mortality

Place	Period	Total death	Age	% died out of total death with reasons	Reference
Sheep breeding farm, Mumidipally	1981-82	745	All age group	Pneumonia -61.00 Enteritis - 6.00 Hepatitis - 6.00 Infectious disease - 8.00 Debility - 5.00 Miscellaneous- 11.00 Low body weight-3.00	Acharya(1982b)
Central Sheep breeding farm, Hissar	1973-74 to 1979-80	6291	-do-	Pneumonia - 23.86 Debility - 15.66 Enteritis - 3.83 Septic wound-3.06 Miscellaneous-53.56	- do -
				<u>% died out of the flock</u>	
CSWRI,Avikanagar(Malpura sheep on range grazing)	1976-79	-	Adult	Gastroenteritis - 10.41 Internal haemorrhage - 5.20 Predation - 4.16 Toxaemia - 2.08 Anaemia - 2.08 Peritonitis - 1.04 Miscellaneous - 6.25	Acharya *et al.* (1980)
- do -	-do-	-	Young	Gastroenteritis - 22.72 Predation - 10.60 Toxaemia - 7.57 Anaemia - 4.54 Pneumonia - 3.03 Miscellaneous - 4.54	- do -

Table 2.12 : Causes of goat mortality

Place	Period	Total death	Age	% died out of total death with reasons		Reference
-	-	-	Young pashmina kids	Pneumonia	-42.00	Mazumdar *et al*.(1980)
				Enteritis	-13.00	
				Pneumoenter-itis	-10.00	
				Coccidiosis	- 9.00	
				Gastroenter-itis	- 7.00	
				Weak/Debility	- 7.00	
				Nonspecific	-12.00	
				<u>% died out of the flock</u>		
CSWRI,Avika-nagar(Native goat on range grazing)	1976-79	-	Adult	Liver abcess, Mastitis, Metritis, Pneumonia, Toxaemia, Predation	1.19 each	Acharya *et al*. (1980)
			Young	Gastroenter-itis	-11.25	- do -
				Toxaemia	- 3.57	
				Predation	- 3.75	
				Congenital	- 3.75	
				Pneumonia	- 1.25	
				Internal-haemorrhage	- 1.25	
				Hepatitis	- 1.25	
				Miscellaneous	- 1.25	
AICRP,Goat, CSWRI,Avikanagar	1978	-	-	Enteritis	-25.53	Annual report, CSWRI(1978)
				Pneumonia/ Pneumo-entris	-19.14	
				Septicaemia	-14.89	
				Internal-haemorrhage	-10.63	

Factors influencing mortality:

The birth weight, sex and pre-weaning gain was reported to influence the survivability of lambs by Bhasin (1968), Raina *et al.* (1973 b), Galal *et al.*(1974), Mani Mohan (1977) and Malik *et al.* (1980). In kids the birth weight was reported to have a significant and direct bearing on mortality during early months of the life by Ali *et al.*(1975) and Mittal (1976). In arid zone, mortality of Marwari lambs was reported to have significant co-rrelation ($P<0.05$) with the minimum temperature by Prasad (1982).

Nutritional Status of Sheep and Goat during different period:

Feed Consumption:

The observation on feed consumption as percent body weight as well in terms of metabolic body weight has been presented below in table 2.13 and 2.14.

The wide variation in feed intake, specially in grazing animals as reported by Cardova *et al.*(1978) was due to the difference in the various technique used for indirect estimation. Gihad (1976), David (1980) and Kurar and Mudgal (1980) reported that the goats in general consume more feed than the sheep.

The dry matter intake by Awasi sheep was reported to be significantly ($P<0.01$) lower under heat stress by Bhattacharya and Hussain (1974). The intake was reduced by 14 and 50 percent with 25 and 75 percent roughage diet respectively, when the environmental

Table 2.13 : Feed intake by sheep

Intake DM basis		Breed	Reference
80.0 g/kg metabolic weight		Border Cheviot ewe	Crompton _et_ _al_. (1960)
83.0 g/kg	- do -	-	Jeffery and Holder (1971)
70.0 g/	- do -	Sonadi	Sharma and Murdya (1974)
30-94 g/	- do -		Moore and Mott (1973)
51-119 g/	- do -(Av=75.9g)	-	Pfander (1970)
51.1-88.2g/	- do -	Utha sheep	Cook and Harris (1951)
36.3 g/	- do -	Australian sheep	Fels _et_ _al_. (1959)
44.1 g/	- do -	- do -	Pearle and Vercoe(1961)
65.7-88.3g/	- do -	Utha sheep	Cook _et_ _al_. (1962)
43.5-58.0g/	- do -	Carlifornia sheep	Van Dyne and Meyer(1964)
40-90 g/	- do -	Grazing animals in general	Cardova _et_ _al_.(1978)
35.0 g/	- do -	Drooper sheep	Gihad (1976)
3.81% of body weight		-	Le Houerou (1980)
2-3%	- do -	-	Rind Singh (1977)
2.53-3.21%	- do -	Utha sheep	Cook _et_ _al_.(1962)
3.03%	- do -	Sonadi	Sharma and Murdya (1974)

Table 2.14 : Feed intake by Goat

Intake(dry matter basis)		Breed	Reference
60.9 g/kg	metabolic weight	Toggenburg	Jones *et al*.(1972)
40.5 g/	- do -	Small East Afri- - can	Gihad (1976)
65.1 g/	- do -	Jamunapari	Sharma and Murdya (1974)
80.32± 2.36 g/	- do -	Sirohi kids	Singh (1979)
3.39% of body weight ±0.17		Sirohi	Singh and Bhatia (1982)
3.24%	- do -	Assamese	Ali *et al*.(1981)
4.7%	- do -	-	Rind Singh (1977)
3.03%	- do -	Jamunapari	Sharma and Murdya (1974)
4.2±0.13%	- do -	Sirohi kids	Singh (1979)

temperature was raised from 22°C to 32°C. Low dry matter intake was also reported with elevated temperature by MC Dowell (1972 b).

Estimation of feed intake by grazing animals:

Acurate determination of the amount of feed/fodder consumed by grazing animals and their digestibility is a subject of considerable practical importance. Many approaches have been utilized to estimate the intake of grazing animals, however, none has proved entirely satisfactory. Most intake trials measure difference in "relative consumption potentials" as reported by Moore and Mott (1973) and Welch and Smith (1969), but does not give absolute intake value. Therefore, intake values are indicative of relative or relative differences in potential intake and have significance for forages only within a given experiment.

Arnold (1960 a), Hardison et al.(1954) and Wilson et al. (1971) reported that due to the heterogenous nature of plant and grass species of the grazing land, stage of growth and selective grazing of the animals and limitations of using faecal collection bag, the conventional in vivo digestion trial is not feasible in range condition. Hence the "indicator technique" has been widely used for estimating the intake and digestibility. The indicator may occur naturally in the forage (internal indicator) or may be administered in known amount (external indicator). The internal indicators are used for estimating digestibility while the external indicator for faecal out put.

Internal indicators:

The internal indicators used for estimating digestibility were chromogen by Reid et al.(1950, 1952), Connon et al. (1963), lignin by Ellis et al. (1946), Wallace and Vandyne (1970), Barsaul (1972), faecal calcium and phosphorous by Viana and Rodriguez (1970), Silica by Kotb and Luckey (1972), faecal nitrogen by Lancaster (1949), Raymond et al.(1954), Kotb and Luckey(1972), methoxyl by Phillips and Goss (1935), Richards and Reid (1952), Anthony and Reid (1958), and fiber by Raymond et al.(1954).

External indicators:

The external indicators used for estimating faecal out put were chromic oxide by Edin (1918), Schurch et al.(1950), Dansky and Hill (1952), Hardison and Reid (1953), Kane et al.(1953), Smith and Reid(1955), Corbett et al.(1958, 1959), Brison and Pigden (1958), Hardison et al.(1959), Elam et al.(1962), polyethylene glycol by Sperber et al.(1953), Corbett et al.(1956, 1958, 1959), Hopson and MC Croskey (1972), chromium compounds like chromium chloride, sodium chromate, Cr-labelled erythrocytes or haemoglobin, metal oxides like feric oxide, tetanium oxide, mineral salts like barium sulphate, cuprous thiocyanate, radio active markers like 51 Cr, 131 Ba, 51 Cr-EDTA with polyethylene glycol, 106 RU (ruthenium), 91 Y (Yttrium), 140 LA (Lathanum), 95 Zr(Zirconium), 46 Sc, 47 SC (Scandium),144 Ce (Cerium), 198 AU (gold) by Kotb and Luckey (1972) and near infrared reflectance spectroscopy (NIRRS) by Norris et al.(1976), Count and Rodloft (1979).

Methods of administring Cr_2O_3 :

The chromic oxide, widely used as an external indicator was suggested to be fed in form of pallets by Brison and Pigdon(1958), Thill et al.(1978) and in gelatine capsule by Putnam et al.(1957).

Period for feeding Cr_2O_3 :

The preliminary feeding of Cr_2O_3 was suggested to be 5 days by Van Dyne (1968), 7 days by Harding and Reid (1953), Majumdar *et al.* (1962) and 11 days by Leonard and James (1977).

Time of faecal sample collection:

The recovery of Cr_2O_3 was reported to be higher in morning hours than in evening by Hardison and Reid (1953), Smith and Reid, (1955), Bloom *et al.*(1957). Using regression analysis, Rittenhouse (1969) concluded that a morning grab sample gave a better estimate of faecal production than taken in the evening.

Estimation of chromic oxide:

The concentration of chromic oxide was estimated by ashing, digestion and absorbance by Germain (1956), Hill and Anderson(1958), Zivkovic and Nowar (1977) and Fenton and Fenton (1979).

Disadvantage of the use of Chromic Oxide:

The faecal estimation through chromic oxide technique was reported to be over estimated by 14%, since, the faecal ash is not included in the standards by Connor *et al.* (1963), Lesperance and Bohman (1963), 11-24% due to faecal grab sampling by Theurer,(1969), 19 and 17 % with *ad lib* and restricted feed, respectively by Wheeler (1962) and non applicability of similar regression equation for all types of animals by Rosiere *et al.* (1980).

Keeping in view the disadvantages it was concluded by Raleigh *et al.*(1980) that :

i) The Cr_2O_3 can be used only for estimating intake and or digestibility on a comparative basis but not on absolute basis.

ii) The comparison should be restricted to one trial and comparison between trials or trials at different time and different conditions should not be compared.

iii) The animals used should be as nearly alike as possible.

iv) Estimation of Cr_2O_3 should be done under uniform analytical conditions and be compared to same standard and be analysed by the same person.

Sampling technique of pasture:

Due to heterogenous nature of grazing land, progressive changes of physical, chemical and botanical characteristics of forage and selective grazing of animals, various sampling techniques of pasture suggested were oesopageal fistula by Fdlefsen *et al.* (1960), Bredon *et al.* (1967), Campbell *et al.*(1968), Jefferies and Rice (1969), Langlands(1969), Wallace *et al.* (1972), eight hours hand plucking following the animal for three consequitive days, collection from mouth prior to swallowing, and random sampling by Rammurthy and Talapatra (1968) for collection of large representative samples.

Nutrient digestibility by sheep and goat:

The nutrient digestibility of sheep and goat was reported to be of similar nature except for crude fiber by Hossain (1960), Mia et al.(1960), Jang and Majumdar (1962), Devendra (1975), Gihad (1976), Hog (1976), Sharma and Rajora (1977), Devendra (1978) which was higher in goats. However, the digestible energy available per Kilogram of dry matter consumed by sheep and goat was reported to be non significant ($P < 0.05$) by Gihad (1976).

Nutrient requirements by sheep and goat:

The nutrient requirement for maintenance by sheep and goat has been presented below in table 2.15 and 2.16,respectively.

Table 2.15: Nutrient requirement by sheep/day (maintenance)

Nutrient requirement	Reference
45.0 g DCP/35 kg body weight	Patnayak (1981)
450.0g TDN/ - do -	- do -
123±16 KcalME/kg Metabolic body weight (127 ± 14 to 146 ± 23)	Young and Corbett (1968)
43 W + 387 Kcal ME,where W = live weight kg.	- do -
255 Kcal DE/kg Metabolic body weight	Martin et al. (1976)
0.132 Mcal ME/ - do -	Smith and Williams (1973)

Table 2.16: Nutrient requirement by goat /day (maintenance)

Nutrient requirement	Reference
2.85 g DCP/kg Metabolic body weight	Singh and Sengar (1970)
2.5 g - do -	Majumdar (1960)
134.75 Kcal DE/ - do -	Singh and Sengar (1970)
141.08 -do- - do -	Majumdar (1960)
100.67-128.56 Kcal ME/ -do-	Kurar and Mudgal (1980)
92.25 - do -	Webster and Wilson (1966)
95.44 - do -	Mackenzie (1967)
124.947 - do -	Kurar and Mudgal (1981)

It was reported by Coop and Hill (1962) that the grazing animals required higher dry organic matter than the similar animals inside the pens. The requirement of energy was also reported higher to the extent of 24% by Langland et al.(1963) and to an extent varying from 10-27% by Young and Corbett (1968) by the grazing animals compared to the similar animals penned inside.

Relative economics:

The goats were reported more profitable than sheep by Abid (1970) , Cook (1970), Acharya and Patnayak (1974), Wahid(1975), Devendra (1978), Ghosh and Khan (1981) and Swain et al.(1982). The profitability was mainly due to their higher feed efficiency and digestibility of crude fiber which was reported by Mia et al.(1960), Jang and Majumdar (1962), Pant et al.(1962), Gallag and Shelton (1972), Devendra (1975), Gihad (1976) and Sharma and Rajora(1977) and better adaptability with higher fecundity and lower mortality as reported by Swain et al.(1982 b).

CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

SITE OF EXPERIMENTATION

The study was undertaken at the Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) located at an altitude of 326 meters above mean sea level (26.18° latitude and 75.25° longitude). The maximum and minimum temperature ranges from 27°-43°C and 4°C - 16°C, respectively. The average rainfall is 53 cm, but it is highly variable both in quantum and distribution. Most of the rainfall is between early July and September months. The land is sandy to sandy-loam with 3.5% clay, 2-2.5% silt and 90-95% sand. The infiltration rate, field capacity and water holding capacity varies from 14-16 cm/hr, 6.85-7.10% and 18-20 inch, respectively. Soil pH varies from 7.2 - 7.5. The organic carbon varies from 0.14 - 0.17% and total nitrogen 0.012-0.02%. The available P_2O_5 and total K_2O ranges from 25-40 and 175-200 kg/ha, respectively (Annual report, CSWRI, 1976). The surface vegetation is mostly covered with annual grasses comprising of *Aristida*-*Perotis*-*Eragrostis* species and top layer mostly with *Acacia senegal* and *Mytenus emarginatus* .

LAY OUT OF THE EXPERIMENTAL FARM

Twenty four hactres of unfertilised range land unsuitable for crop cultivation was fenced and divided into two equal plots. One plot was alloted to 15 native Malpura and 15 cross-bred

(Rambouillet x Malpura ½) ewes with one cross-bred ram, and the other plot to 15 native Sirohi and 15 cross-bred (Beetal x Sirohi ½) does alongwith one cross-bred buck. A central thatched hut was provided for animals as well as for the grazier.

GENERAL MANAGEMENT The animals were allowed free grazing from morning till evening in their alloted plots. No supplementary feeding was provided to these animals except for loppings available from the grazing area. Mineral mixture bricks were made available at the correls for licking by the animals. Free natural mating was practised and to prevent inbreeding the breeding male was replaced every year by the Institute. The progeny born was carried along with the adult stock till the young males attained six months of age when they were disposed off, and the young females till they lambed or kidded and there after they replaced the old females to maintain the number of breedable females constant (15 from each breed groups). Dead adult females, if any was replaced by the farmer family. Routine prophylactic health cover was provided regularly.

The animals were given to a farmer family consisting of two members with the condition that the family will have to return back the same number of animals (62) at the end of the experiment i.e. at the end of 2nd year. The family was not given remuneration but was allowed to take all the products, viz., milk, wool, manure, hide, surplus and or culled animals.

CLIMATIC FACTORS The temperature humidity index (THI) and the temperature humidity sunshine index (THSI) were calculated as per MC Dowell (1972a) and Thomas and Acharya (1981), respectively (Table 4.35). Data related to dry and wet bulb temperature at 9 h, 15 h, and the hours of day light were obtained from the Institutes meteorological observatory.

$$THI = 0.72\ (C_{dbt} + C_{wbt}) + 40.6$$

$$THSI = \frac{0.75\ S\ (THI\ at\ 3\ PM) + 24-0.75\ S)\ x\ THI\ at\ 9\ AM}{24}$$

Where as: S = Hours of day light

C_{dbt} = Dry bulb temperature °C

C_{wbt} = Wet bulb temperature °C

FODDER RESOURCES

Before introducing the animals to the experimental plots the surface and top feed resources were surveyed with respect to botanical composition and yield during September - October, when most of the vegetations of the range land was at peak flowering stage.

The percent cover of the surface vegetation was estimated through line intercept method as suggested by Canfield (1941). The two ends of a 5' long thin metalic wire were tied to two iron pegs and randomly placed closely over the surface vegetation at five different places. The basal cover of different grass species exactly below the metalic wire were measured by a scale upto the accuracy of 0.5 mm length for determining the percent cover and the grass species were identified through their florescence. The surface vegetation yield was determined through square foot density method of Stewart and Hutchings (1936). Surface vegetation of one square meter area each from five different places was cut close to the ground, sun-dried and the weight taken to estimate the total dry matter yield.

The number of trees/shrubs/climber per unit area was estimated through strip survey method of Bhimaya and Ahuja (1968). Five plots measuring 1000 square meter each (50 x 20 meters) were randomly selected at different places and the trees/shrubs/climbers available were counted for estimating the total number of different species of trees/shrubs/climbers available per unit area. In order to estimate the dry matter yield from top feed resources, the available trees/shrubs/climbers were totally lopped from the above said plots, sundried and the leaves were separated and weighed.

GRAZING BEHAVIOUR OF SHEEP AND GOAT WITH RESPECT TO DISTANCE TRAVEL

The distance travelled by grazing sheep and goat during spring season (March-April) was measured with the help of Pedometer according to Anderson and Kothmann (1977). One adult female from each of the four breed groups was taken to standardize the foot steps. Hoof of right fore limb of the animal was covered with a thin layer of cotton and tied with a piece of bandage cloth before dipping in used (black) mobil oil. The animal was then allowed to move freely on a coaltar road along with other animals. While walking on the coalter road the animal left foot prints (right hoof) and the distance between two foot prints were recorded. Observations were recorded both in the morning and evening. Accordingly, 100 observations during each period were taken. Since, the distance between two foot prints measure distance of two foot steps (as the animal lift the leg alternatively, viz., right-left-right) the data thus obtained were divided into two and the distance covered through one step was standardized separately for each animal. The pedometer needle was then set at 'zero' using the knob provided at the back and the foot step was adjusted using another knob provided at the right side. One animal from each group was used for estimating the distance travelled per day for three consequitive days. On the first day of observation the body biometry (length, height, heart girth) of the animal was also recorded. The Pedometer after necessary adjustments was placed inside the shock and waterproof hobble and tied just above the right hoof of the forelegcovering two third of the metacarpel bone. The animal was allowed to graze freely throughout the day and in the evening (after 12 hours) the pedometer was removed and the distance travelled (KM) was recorded. The meteorological data with respect to dry and wet bulb temperature at 9 h, 15 h and hours of day light was also recorded.

ANIMAL PERFORMANCES

Body weight: The body weight of adult females was recorded at monthly intervals by a 'Salter'spring balance . The body weight of animals three months pre and two months post lambing/kidding (advance stage of pregnancy and early lactation, respectively) were excluded before interpreting the influence of physical environment on body weight changes. Body weight of the lambs and kids was recorded at birth, 90 days, 180 and 365 days of age.

Milk yield: The milk yield of the does was recorded every fortnight by complete hand milking and was discontinued when the yield per milking was about 50 grams.

Wool yield: The sheep were machine shorn at six monthly intervals and the greasy fleece weight was recorded with an accuracy of 20 grams. Due to fixed shearing schedule (twice in a year at six monthly interval) the lambs approaching or slightly more than six months of age were shorn along with the adults and the greasy fleece weight for each lamb was adjusted to 180 days. Immediately after shearing the body weights of the animals (adult and lambs) were taken for expressing the greasy fleece yield per unit body weight. In addition, the total hours of day light to which a lamb had been exposed was calculated considering the date of birth and shearing, to study the influence of hours of day light on greasy fleece yield.

Reproductive performances:- Reproductive performances included in the experiment were the incidences of kidding/lambing, incidence of multiple birth, season of kidding/lambing, occurance of heat, preponderance of heat in the different periods, kidding/lambing interval, age at first kidding/lambing and the weight at first kidding/lambing etc.

Livestock loss:- Proper records of losses either in the form of death or otherwise was recorded. In case of deaths, proper post-mortem investigation was performed but no histo-pathological investigations could be arranged.

NUTRITIONAL STATUS DURING DIFFERENT PERIODS

Forage intake and its utilisation by the experimental animals was studied in March, June, September and December. Chromic oxide was used as external indicator and lignin as internal indicator to estimate the forage intake as well as nutrient utilization.

Two, dry (non pregnant) females of similar age and weight from each breed/breed groups were selected for the digestibility trials. Each animal was fed 2 g of chromic oxide on paper packs using a pair of esophageal forceps every day during morning hours (6-7 h) for a period of 12 days. During collection period (last fivedays) faecal grab samples weighing approximately 100 grams were collected daily from each animals in the morning (6-7h). Representative forage samples were also collected daily by hand plucking as close as possible from the grazing sites personally, following the animals for a period of about 2 hours. The oven dried faecal samples of individual animals obtained for a period of 5 days were mixed, ground and a representative sample of about 100 grams were kept for subsequent analyses. The forage samples were also oven dried and stored for further analyses. The body weight of the animals were recorded on eighth and thirteenth day of the experiment.

RELATIVE ECONOMICS

The relative economics was calculated by accounting for the revenue obtained through sale proceed of milk, wool, manure,hide, surplus animals and the expenditure incurred for maintenance and upkeep of the experimental animals.

ANALYTICAL

Chemical analyses:

Chromic oxide:- The chromic oxide in the faecal sample was estimated as per Hill and Anderson (1958) and faecal out put was calculated as under:

Preparation of digestion mixture:- Ten grams of Sodium molybdate was dissolved in 150 ml of distilled water. To this solution 150 ml of Con.H_2SO_4 was added slowly and the solution was cooled in an ice bath. After the solution was cooled, 200 ml of 70% Perchloric acid was added with stirring.

Pre-digestion:- Ten milligram of Chromic oxide was transferred to a 100 ml Kjeldahl flask and 10 ml of Con. HNO_3 was added to it and it was kept over night. The mixture was heated over a micro-flame next morning to dryness.

Digestion:- To the Kjeldahl flask 15 ml of digestion mixture was added and the digestion was continued over the microflame till the colour of the solution changed from blue to green, orange and finally to yellow. The Kjeldahl flask was then cooled immediately. The solution in the Kjeldahl flask was diluted by adding approximately 50 ml of distilled water and was filtered to a volumetric flask of 100 ml capacity. Finally, the volume was made 100 ml and the optical density was measured at 430 m/u by the help of a Spectrophotometer.

Preparation of standard Curve:- The 100 ml stock solution thus prepared contained 10 mg of Cr_2O_3 which was equivalent to 100/ug /ml of the solution. Stock solution measuring 5.0 ml was transferred to each of the four test tubes and was diluted with 0,5,15 and 35 ml of distilled water to have the concentration of Cr_2O_3 100, 50,25 and 12.5/ug/ml. Similarly, the stock solution measuring 7.5 ml was transfered to each of the two test tubes and was diluted with 2.5 and 12.5 ml distilled water to have the concentration of 75 and 37.5 /ug /ml. The optical density of these diluted sample was estimated at 430 m/u wave length using Spectrophotometer and the common factor (Con./OD) was thus found out as follow:

Stock solution (ml)	Distilled water added(ml)	Con.of Cr_2O_3 (μg/ml)	Transmission	O.D.at 430 mμ	Factor = Con/OD
5.0	0	100.0	52	0.284	352.11
7.5	2.5	75.0	60	0.222	377.84
5.0	5.0	50.0	68	0.168	297.62
7.5	12.5	37.5	75	0.125	300.00
5.0	15.0	25.0	83	0.081	308.64
5.0	35.0	12.5	90	0.046	271.74

Average factor (Con/CD) = 318.00/ml

Hence, when the faecal sample containing unknown quantity of Cr_2O_3 diluted to 100 ml, the total quantity of Cr_2O_3 must be 100 x Factor x OD or 31800.0 x OD.

If 2 g of Cr_2O_3 is fed to the experimental animals and 1 g of faecal sample is taken for estimating the total faecal output and the sample is diluted to 100 ml, then the total faecal output will be 2,000000 μg $\div$ (31800.0 x OD).

Under the present experiment "USSR" make Cr_2O_3 was used for preparation of standard curve as well as estimation of total faecal output.

Lignin:- The lignin both in feed and faeces was estimated as per Van Soest (1963) and feed intake was collected as under:

ab = cd, where a = % lignin in faeces

b = quantity of faeces voided

c = % lignin in feed

d = quantity of feed consumed

Preparation of stock solution

a) Acid detergent solution: 49.04 g of Con. $H_2 SO_4$ was weighed in a glass beaker over a top pan balance and the volume was made to 1.0 liter. The solution was then standardize to 1 N by titration and finally 20.0 g of CTAB(Cetyl trimethyl ammonium bromide) was added with stirring.

b) Preparation of 72% H_2SO_4(W/W): The laboratory grade Con.H_2SO_4 has 98.08% purity and 1.835 specific gravity. In order to get cent percent pure con. H_2SO_4 the amount was thus calculated to be 101.95 ml which weighed 183.5 g. Hence, in order to get 72 g of H_2SO_4,the amount of acid required was 40.002 ml and the rest 28g water was 28.0 ml.

Procedure of estimating lignin: Finely grounded sample (feed/ faeces) weighing 1.0 g was transfered to a one liter spoutless beaker and to it 100 ml of acid detergent solution was added. The solution was then refluxed with slow and even boiling over a hot plate for 60 minutes. Antifrothing agent like sodium sulphite was added in very little quantity when ever required. After the reflux for a period of 60 minutes, it was filtered over a gooch crusible on a filter manifold, breaking the clumps with glass rod and pouring hot distilled water. The washing was repeated with hexane and acetone. The crusible was thendried in the oven at 100°C over night and then cooled. To this crusible, 72% H_2SO_4 was added and the dried sample was made in to paste breaking the clumps by a glass rod. The crusible was refilled thrice with 72% H_2SO_4 and stirred and finally filtered through vacum, washing with hot distilled water till it was free from acid. The glass rod was rinsed and removed. Then the crusible was dried in the oven for 24h at 100°C, finally cooled and weighed. The crusible was then placed in a muffle furnace at 500-550°C till complete ashing (5-6h), then cooled in a desicator and the weight was taken. The percent lignin was thus calculated as follow:

$$\% \text{ Lignin} = \frac{L \times 100}{s}$$

Where = L = Loss of weight upon ignition

S = Weight of the sample taken

<u>Proximate analysis</u>: Analysis for proximate constituents both in feed and faeces were done as per AOAC (1965).

<u>Estimation of gross energy</u>: The gross energy of faeces and feed samples was estimated by using ballstic bomb calorimeter as detailed below:

<u>Principle of bomb calorimeter</u>: When a sample is burnt (electrically) in a sealed chamber filled with pure oxygen, heat is produced incr-easing the temperature of the bomb. The rise in temperature is either absorbed by the water surrounding the bomb and measured

through a sensitive thermometer (Backmans) in case of isothermic bomb calorimeter or directly measured by a galvanometer in case of adiabatic (Ballstic type) bomb calorimeter.

Ballstic type Bomb calorimeter: The ballstic type bomb calorimeter contains one bomb unit, one firing unit and one galvanometer. In order to standardize the bomb calorimeter i.e. grass energy liberated per degree rise in temperature, known amount of benzoic acid having gross energy 6319 cal/gm was burnt in side the bomb filled with pure oxygen at a presure of 25 kg./Cm^2. The rise in temperature was measured by the galvanometer and the gross energy thus liberated per degree rise in temperature was calculated. Accordingly, the gross energy liberated from the samples determined by multiplying the degree rise in temperature of the galvanometer with the calories of energy per degree.

While standardizing the ballstic bomb calorimeter the rise in temperature due to burning of thread was 0.21 degree and the average gross energy liberated per degree rise in the galvanometer was 0.5203006 Kcal.

Statistical analysis: The data were subjected to analysis as per Steel and Torrie (1960).

CHAPTER - IV

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

FODDER RESOURCES

The surface vegetation resources estimated through line intercept (Table 4.1) was found to have a percent cover of 4.28 and the dry matter yield was only 8.65 quintals/ha indicating poor feed resources of the semi-arid area under study. The major grass species were Aristida-Perotis-Eragrostis species, all being annual in nature.

The top layer of the study area (Table 4.2) was predominantly Acacia senegal (58.3%) which had very small leaves and sharp thorns on the tender twigs. Green pods of Acacia senegal are available at a time when most of sheep and goat are in advance stage of pregnancy (October-November). However ,during December and January months the pods dry up and shed seeds.

Mytenus emarginatus which sprouts during the months of March-April was the next predominant tree with a population of 12.5%. The rest of the species were shrubs and individually were not prominent, but in totality contributed 29.2% to the top feed resources.

The dry matter yield from the top feed resources in the study area was found to be 6.2 Q/ha.

In general, the range land under study was poorly vegetated both in terms of ground and top feed resources.

GRAZING BEHAVIOUR WITH REFERENCE TO THE DISTANCE TRAVELLED AND THE PHYSICAL ENVIRONMENT

During routine grazing the distance travelled by sheep and goat was studied in relation to their body biometry and the physical environment (Table 4.3). A positive and highly significant ($P \angle 0.01$) co-rrelation ($r=0.998$) between height of the animals at whither and average distance travelled per foot step was indicated. The difference in average foot step between goat (48.065 cm) and sheep (38.415 cm) was mainly due to difference in their heights (80.5 Vs 64.0 cm).

In both the species, irrespective of the breed groups the average foot step was found to bear a similar relationship (Table 4.4) with the height at whither averaging to 0.59871 ± 0.00117 times of the height. Considering the height at whither as radius of a circle and the average foot step as a part of the circumferance, the angle of movement of the foreleg was also found to bear a similar trend and was 34.003 , 34.420, 34.175 and 34.614 degree in native goat, cross-bred goat, native sheep, and cross-bred sheep, respectively averaging to 34.3 ± 0.134 degree. With respect to breeds, native goat travelled 14.784 Km compared to 13.824 Km in cross-bred goats and 10.625 Km in native sheep compared to 9.708 Km in cross-bred sheep per day indicating that goats walk more than sheep and the natives walk more than cross-breds.

On an average the goats had to cover 4.0 Km (Table 4.5) more per day compared to sheep to fetch approximately the same amount of dry matter (Table 4.32). Both the species were allowed to graze on identical vegetation in the adjoining grazing land, even then the goats had to cover a wider area per day. It definitely indicates a difference in the grazing behaviour between the two species.

Thus grazing behaviour of goat gives an impression that they must be spending more energy to get their feed compared to sheep, but our finding in this experiment indicated that the average distance per foot step are positively co-related with the height of the animal. Eventually, goats having higher height at whither than sheep, had wider foot steps (Table 4.4). The sheep while travelling the distance of 10.166 Km had to use 26,463 steps as against 29,759 steps by goat (Table 4.3) to cover 14.304 Km. On the coverage of the distance the goat travelled 40.7% more distance as compared to sheep but on the basis of number of foot steps it hardly exceeded more than 12.4%.

The goats being a very selective grazier had to cover some more distance than sheep for their feed intake. This wide coverage provides the oportunity to come across succulent feeds with rich in nutrients. This species in general is an efficient converter of the nutrient as compared to sheep. This behaviour of goat, therefore, may be considered as beneficial rather than a wasteful expenditure of energy. This statement is justified from the performance record of this species on all the parameters studied in this experiment.

The average distance travelled per day by goat and sheep (Table 4.5) was 14.304 $\pm$ 0.292 Km and 10.166 $\pm$ 1.049 Km, respectively and was negatively co-rrelated with the physical environment. The co-rrelation value (r) was -0.173 for goat and -0.817 for sheep and it varied significantly from zero ($P \angle 0.05$) only in case of sheep.

ANIMAL PERFORMANCES

Adult body weight:

Goats: The overall body weight during the experimental period (Table 4.6) in native and cross-bred goat was 34.9 $\pm$ 0.57 and 31.6 $\pm$ 0.78 Kg, respectively.

In the present experiment the body weight and growth performance of the natives were recorded to be superior to the cross-breds. The performances of the cross-breds was expected to be superior , but in reality it was the reverse when studied on natural degraded range land.

The increase or decrease in body weights in different months from January through December (Table 4.6 and Fig.1)maintained an identical trend in both the genetic groups. The percent increase or the decrease of the natives or the cross-breds during all the months maintained uniformity barring April-May, May-June,

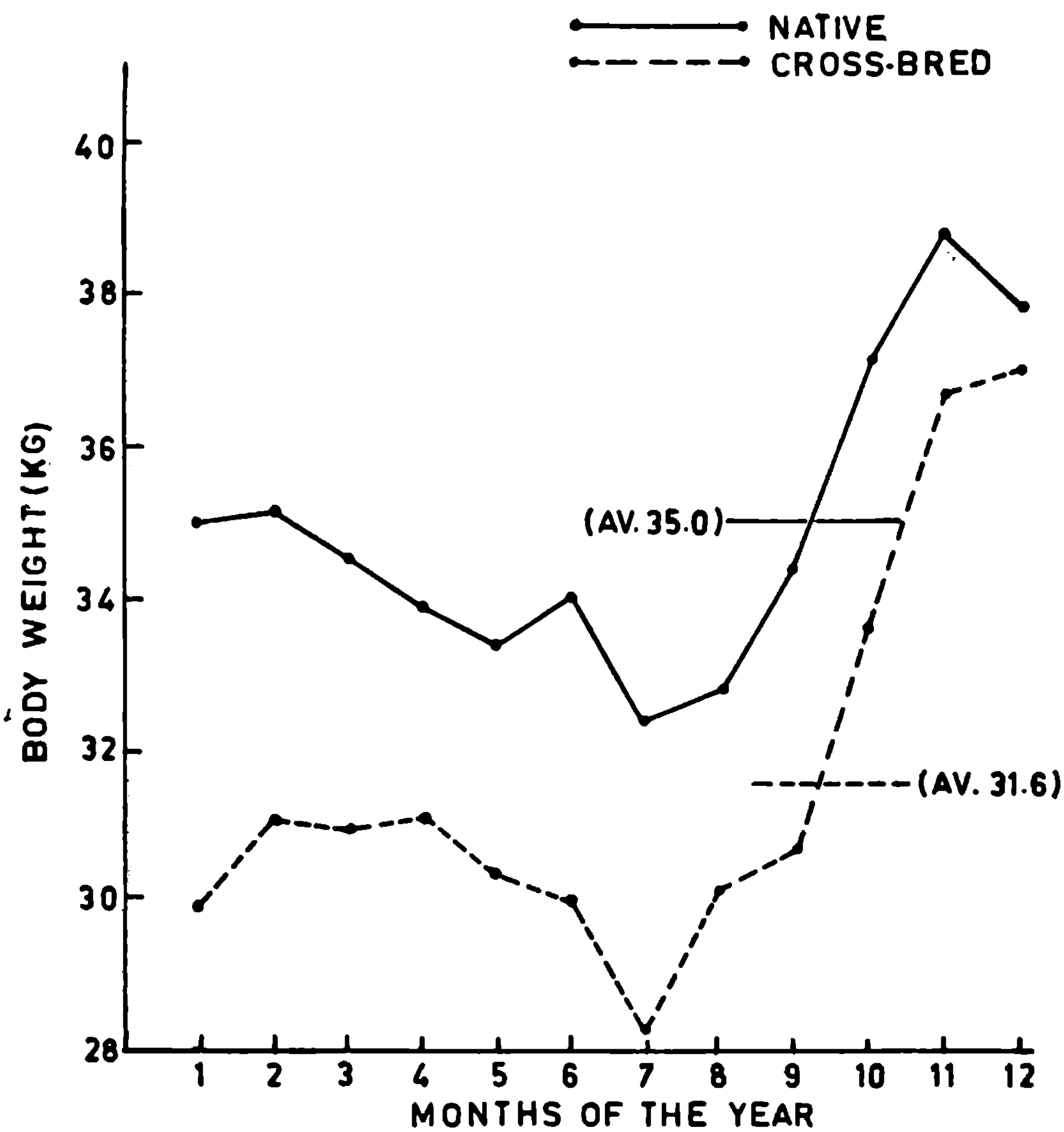
June-July and August-September. During these periods the native gained proportionately more weight as compared to the cross-breds (Table 4.7).

The records of THSI (Table 4.33) indicated highest value from April to September. The native animals which are adapted to such an environment for generations, are expected to perform better as compared to cross-bred animals.

When the stocking rate of these breeds were considered, it was found that the natives (Table 4.7) excelled the cross-breds at higher stocking rate. During August-September, the native gained weight to the extent of 4.9% with 29 animals on the grazing field. During the same period, the gain in body weight of the cross-bred goats were 2.0% with 20.5 animals in the grazing field.

The magnitude of maximum increase and decrease in body weights from the average body weight (Fig.1) was 10.86, 17.1 and 7.43, 10.45 per cent in native and cross-bred goats, respectively. Lesser degree of fluctuation among the natives compared to cross-breds could be due to their better adaptability to the semi-arid conditions. The decline in body weights was maximum in both the breeds during June, which may be due to poor availability of quality feed/fodder resources in addition to hot environment (THSI = 82.73). Decline in body weights with hot environment was also reported by MC Dowell (1966).

FIG.1 BODY WEIGHT CHANGES OF GOATS



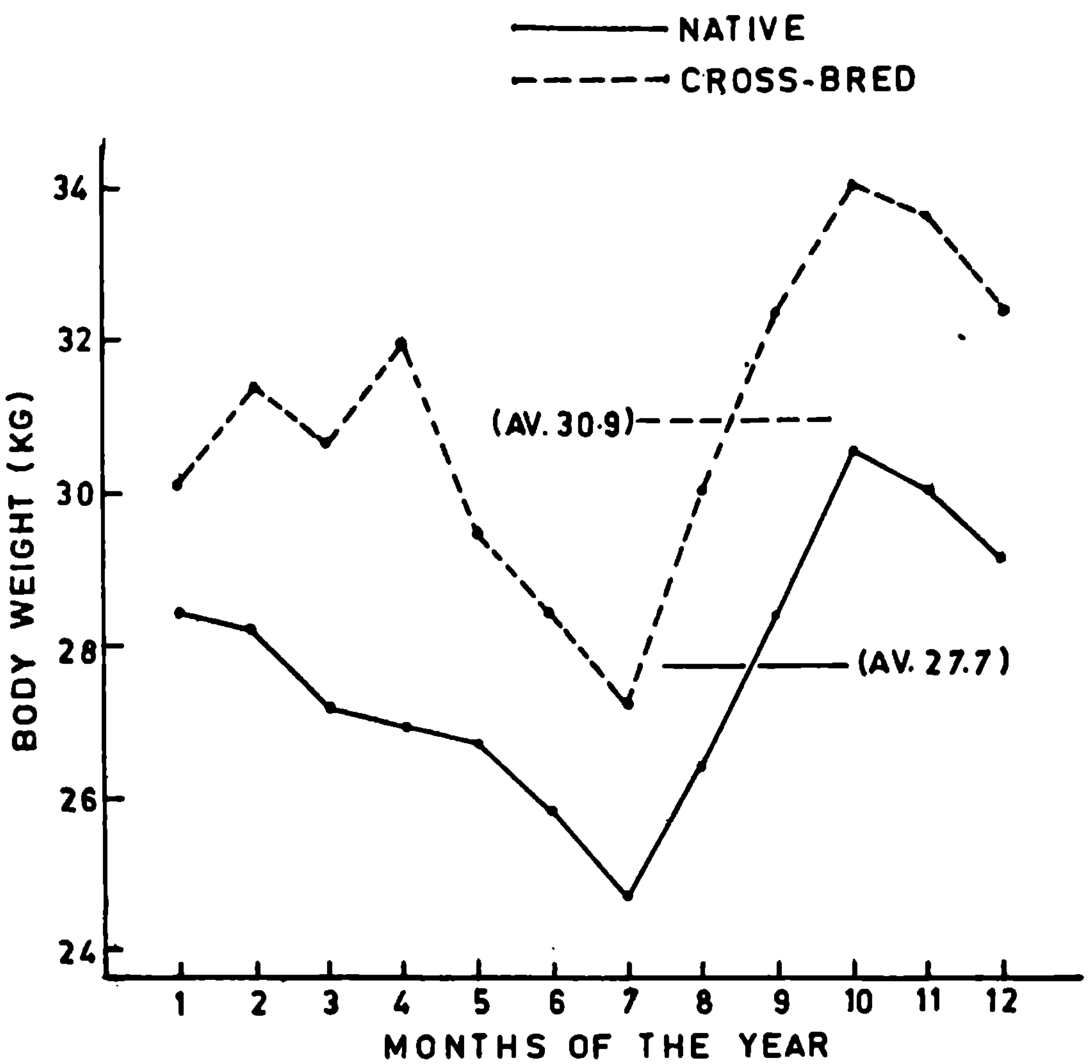
Sheep: Overall body weight during the experimental period (Table 4.8) in native and cross-bred sheep was 27.68 ± 0.49 and 30.93 ± 0.58 Kg, respectively.

The native sheep between January through April lost in body weight to the extent of 5.28 percent, while cross-breds gained in weight by 5.98 percent (Table 4.9) with almost identical stocking rate (22.25 Vs 24.66). The gain in body weight among cross-breds may be due to the influence of shearing that results in higher digestibility of nutrients and thereby reflecting through body weight changes. Higher dry matter digestibility ($P<0.05$) and body weight gains among the cross-breds over native sheep during post shearing was also reported by Swain et al.(1982 a) under uniform grazing conditions. The percent decline in body weights between April and August was 1.86 and 5.96 percent (Table 4.9) among native and cross-breds. This indicated that native sheep were well adapted to the harsh physical environment of the semi-arid tropics during summer than cross-breds. Between August and December both native and cross-breds gained in body weight to the extent of 10.2 and 7.7 percent, respectively. The increase in body weights may be due to availability of ample vegetation both from ground and top feed resources.

Body weight changes and the physical environment:

The co-rrelation between physical environment as indicated by THSI (Table 4.10) and body weight was found to bear significantly negative

FIG. 2 BODY WEIGHT CHANGES OF SHEEP



co-rrelation and it was 0.596, 0.4692, 0.440 and 0.4156 for native goat, cross-bred goat, native sheep, and cross-bred sheep, respectively. The body weight was lower in both the species during summer (April-June) when the average THSI was 78.888 $\pm$ 1.80 as compared to autumn (September-November) when the average THSI was 70.478 $\pm$ 2.56. This may also reflect the availability of the vegetation.

Birth weight and growth rate:

Kids: At birth, the native and cross-bred kids (Table 4.11) weighed 2.80 $\pm$ 0.057 and 3.09 $\pm$ 0.071 kg, respectively and the higher birth weight among the cross-bred kids (10.36%) were significant ($P \angle 0.05$). The male kids weighed 3.13 $\pm$ 0.807 and 3.29 $\pm$ 0.112 kg for natives and cross-breds while the female kids of the breed in order weighed 2.67 $\pm$ 0.075 and 2.89 $\pm$ 0.09 kg, respectively. Higher birth weight among male kids were also reported by Epstein and Herz (1964). At subsequent stages of growth cross-bred kids weighed more than natives by 5.6, 8.1 and 6.7 percent at weaning (90 days), six month and at twelve months of age, respectively.

Lambs: At birth the native and cross-bred lambs (Table 4.12) weighed 2.73 $\pm$ 0.92 and 3.21 $\pm$ 0.08 kg, respectively and the higher birth weight among cross-bred lambs (17.58%) were significant ($P \angle 0.01$). The male lambs weighed 2.85 $\pm$ 0.15 and 3.33 $\pm$ 0.14 kg for natives and cross-breds while the female lambs of the breed in order weighed 2.61 $\pm$ 0.11 and 3.11 $\pm$ 0.09 kg, respectively. Although the body weight of cross-bred lambs at birth were higher than natives, but at subsequent stages of growth natives exceeded that of the cross-breds by 11.5, 7.3 and 25.9 percent at weaning, six month and at twelve months of age, respectively.

As the birth weight of the cross-breds was higher, it may be assumed that the cross-bred ewes derived optimum nutrition for the neo-natal development of the foetus. Therefore, the sub-optimal status of nutrition of the ewes, perhaps may not sustain higher growth rate of the lambs in post-natal stage.

It is difficult to put forward a probable reason for such an occurance in this experiment. It remains to be seen whether the native ewes produced more milk with superior nutritive value as compared to the cross-breds under identical condition. However, the investigator is of the opinion that further investigation should be undertaken with more number of animals and covering wider parameters for this purpose.

Average daily gain:

The average daily gain in weights during various phases of the species and breed groups have been presented in table 4.13.

The average daily gain among native kids was 86.22 g and cross-breds 89.55 g in the pre-weaning stage. Similar higher average daily gain in cross-bred kids (64.89 Vs 57.33 g) was also maintained in the post weaning phase. However, the average daily gain among cross-bred (68.89 g) and native (69.0 g) female kids was uniform during 6-12 months of age. In lambs, the average daily gain among natives was higher than in the cross-breds during pre-weaning (95.66 Vs 77.22 g), between 6-12 months of age (29.83 Vs 13.33 g) and was almost similar during post-weaning (58.44 Vs 58.89 g)period.

Influence of physical environment on pre-weaning gain:

The pre-weaning gain (0-3 months) for both the species irrespective of breed groups and sex was found to be negatively correlated with hot environmental conditions (Table 4.14). This relationship was, however statistically significant ($P \angle 0.05$) in case of native male and female kids and the cross-bred females only. Similar negative co-rrelation with elevated temperature was also reported by Mc Dowell (1966).

Lactation length:

The lactation length of native and cross-bred goats pooled over different lactations (Table 4.15) was 149.62 $\pm$ 4.99 days (range 112-182 days) and 160.47 $\pm$ 5.62 days (range 124-186 days), respectively and the difference was non-significant.

Lactation yield:

The lactation yield of native and cross-bred goats pooled over different lactations (Table 4.15) was 44.87 $\pm$ 2.48 kg (range 21.00 - 66.0 kg) and 47.82 $\pm$ 2.59 kg(range 34.05 - 69.8 kg), respectively and the difference was also non significant.

Lactation Curve:

The adjusted average milk yield during different post kidding fortnights (Table 4.16 and Fig.3) indicated that the average milk yield was 0.26 and 0.27 kg in native and cross-bred goats. The milk yield reached peak during the third fortnights of post-kidding in both the groups while only in cross-bred it was maintained for one more fortnight and then gradually declined till thirteenth fortnight of post kidding in both the groups. The peak yield among native was 0.45 kg which was 73.0% higher than the average value. This peak yield in cross-breds was 0.46 kg and was 70.4% higher than the average milk yield.

However, in both the groups the fortnightly milk yield remained above the adjusted average value (Fig.3) between first and seventh fortnights of post kidding.

Monthly Milk Yield:

The average milk yield during different months of the year (Table 4.17 and Fig.4) indicated that the milk yield per day in different months averaged 297.8 and 287.7 g in native and cross-bred goats, respectively. The peak milk yield was during the months of December in both the groups which was 467.9 and 485.7 g in native and cross-breds, respectively. The peak yield was higher in December by 57.1 and 68.8% among native and cross-breds does, respectively than the average.

FIG. 3 ADJUSTED AVERAGE MILK YIELD (KG) DURING DIFFERENT FORTNIGHT OF POST KIDDING

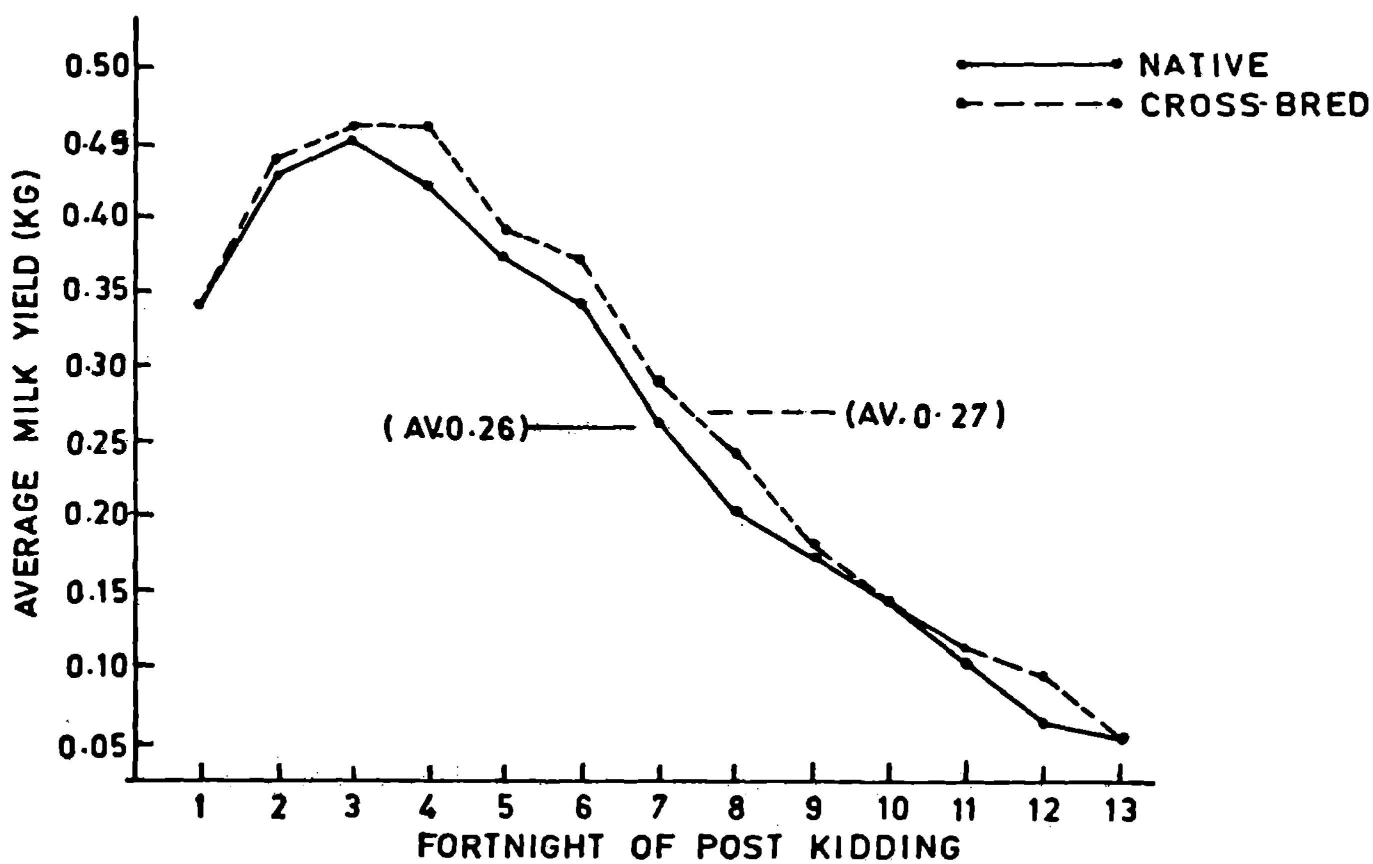
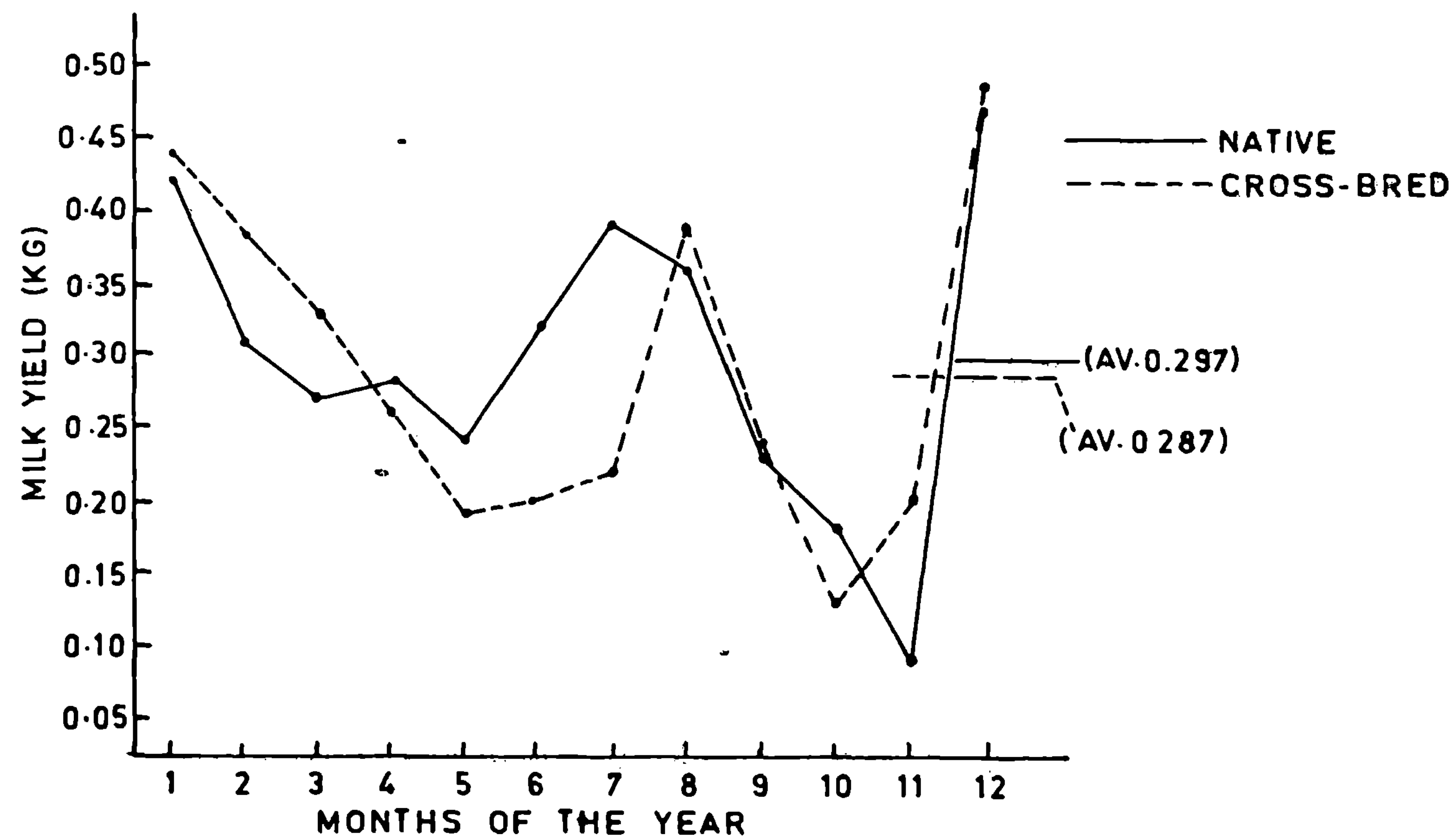


FIG.4 AVERAGE MILK YIELD (KG) DURING DIFFERENT MONTHS OF THE YEAR



Greasy fleece yield of sheep:

The average greasy fleece weight per annum (Table 4.18) indicated significantly ($P \angle 0.01$) higher wool yield among the cross-breds (1.587 ± 0.116 kg) compared to the natives (0.772 ± 0.555 kg) to the extent of 105.57 percent. Greasy fleece yield when calculated on the basis of body weight (g/kg BW) was also significantly ($P \angle 0.01$) higher in cross-breds (23.69 ± 1.58g) compared to natives (13.88 ± 0.92 g) by 70.68 percent.

Greasy fleece yield among native as well as in cross-breds was lower in autumn than in spring season (Table 4.18). In case of native and cross-breds the yield in autumn was lower than in spring by 23.15 and 42.52 percent, respectively and it varied significantly ($P \angle 0.01$) only in the cross-breds.

Nagarcenkar and Bhattacharya (1964 a,c) reported lesser wool yield during autumn which they ascribed to high humidity with high atmospheric temperature.

The greasy fleece yield among lambs (Table 4.18) adjusted for 180 days of age was almost equal both in native (492.4 ± 71.1 g) and cross-breds (490.9 ± 57.8 g), while the yield per kg body weight was higher in cross-breds (13.28 ± 4.43 g) by 6.7 percent over natives (12.45 ± 3.27 g). Though statistically not significant, the greasy fleece yield per 100 hours of day light was higher in cross-breds than in the natives by 18.75 percent.

Age at first kidding
and kidding interval:

Goat: Age at first kidding (Table 4.19) in native and cross-bred goat was 458 ± 23 and 449 ± 18 days, respectively. Apparently from these figures the age at first kidding did not record any wide variation. The body weight at first kidding of the respective breed was 28.35 and 28.13 kg, respectively. As the animals were served by natural service the weight at maturity could not be recorded. However, from the age at first kidding as well as the body weight at first kidding it may be assume that both the breeds attained identical body weights and age at maturity.

On the other hand the kidding interval of the natives was 299 ± 19 days whereas it was 388 ± 33 days in case of cross-breeds. This difference of 89 days was considered as a very wide variation between the breeds and was statistically significant($P < 0.05$).

When the breeds attained identical age and body weight at maturity as well as at first kidding, the inter kidding period appeared to be very wide. During the course of the investigation no reproductive disease such as pyometra etc. could be detected. Therefore, this wide variation of kidding interval could not be attributed to disease specific to reproduction. The defect in the male component was also ruled out as the same buck was used for both the breeds.

Therefore, it would be reasonable to assume that such cross-bred animals require some more time for appropriate adaptation and better management in general and heat detection in particular.

Sheep: The age at first lambing in native and cross-bred sheep was 606 ± 97 and 680 ± 10 days, respectively. The body weight at first lambing of the respective breeds was 28.2 and 29.4 kg, respectively. The lambing interval of the native sheep was 401.34 days and in cross-breds it was 386 ± 47 days. This difference (15 days) was not statistically significant.

Tupping frequency:

Goat: The tupping frequency (Table 4.20) indicated that the breeding of goats can take place during most of the year indicating non-seasonality in sexual activity.

Non seasonality in breeding activity among goats was also reported by Amble et al.(1964) and Pant (1979).

In native goats, the tupping percentage was higher during July (46.67%), followed by September and October (23.33% each). In cross-breds, it was also highest in July (30.0%) followed by September (23.33%).

The tupping frequency in general remained at peak from June to November in both the breeds. During these periods the fodder resources available were in plenty. In addition to the fodder resources, the hours of sunshine as recorded during the experimental period (Table 4.33) indicated lesser hours of sunshine between June to November (8.715 $\pm$ 0.446 h) compared to rest of the months (December - May) and was 9.71 $\pm$ 0.30 h. During July, in particular when the tupping percentage in both the groups was higher, the average hours of sunshine was also low (6.81 $\pm$ 1.32 h). This indicated that the tupping had a negative co-rrelation with the hours of day light. Similar observations were also recorded both for sheep and goat by Prasad (1954), Fraser and Laing (1969), Ducker and Brown (1970 a,b), Ducker _et al._ (1970 a,b), Newton and Betts (1972) and Schanbacker (1980).

THSI during the months from June to November was higher (74.97 $\pm$ 1.91) than that during the months of December to May (65.89 $\pm$ 2.85). During July in particular the THSI was 78.07 $\pm$ 0.05 and was higher than the annual average THSI (70.63 $\pm$ 1.91).

Sheep: The tupping frequency among native and cross-bred sheep (Table 4.20) has also indicated that the breeding can take place during most of the year indicating non-seasonality in sexual activity.

Non-seasonality in breeding activity among sheep was also reported earlier by Hafez (1953), Taneja (1966) and Sahni and Roy (1967).

In native sheep the tupping percentage was highest during July (20%) followed by August (13.33%). In cross-bred sheep the tupping percentage was highest in September(43.33%) followed by July (23.33%).

The tupping frequency in general remained at peak from July to November in both the breeds. During these periods the availability of grazing resources were in plenty in addition to lesser hours of day light(8.73 $\pm$ 0.52) than rest of the months (Dec-June) and was 9.54 $\pm$ 0.29 h. This also indicated that the tupping percentage had a negative co-rrelation with the hours of day light. Similar observation recorded by various works has already been cited earlier.

The THSI during the months between July to November was however higher (73.41 $\pm$ 1.91) than rest of the months (Dec-June) and was 68.49 $\pm$ 2.98.

It has already been established by Prasad (1959), Fraser and Laing (1969), Ducker and Brown (1970 a,b), Ducker et al.(1979 a,b), Newton and Betts (1972) and Schanbacker (1980) that sexual activity of sheep and goat is dependent upon the variation of the hours of sunshine and is higher during shorter hours of sunshine. In thepresent study the trend of reproduction in relation to sexual activity is in conformative with the previous scientific recordings.

In the present investigations, besides the hours of sunshine the effect of temperature and humidity have been used to co-rrelate with this trait. From the THSI value it was seen that the occurance of heat i.e. the onset of reproductive activity could be co-rrelated with the THSI. With the limited figures generated in this experiment it may be said that the reproductive activity of sheep and goat was positively co-rrelated with the THSI. In general, the ovarian activity both in sheep and goat was found to be very high during June-July which coincided with the maximum value of the THSI. The THSI value decreased with the onset of rains from July onwards will September-October and the frequency of tupping also followed a generalised pattern of decrease. As both the species do not exhibit seasonal breeding pattern in this sub-continent, it is not expected to follow this trend absolutely. From our limited observations it may be concluded that the THSI may be taken as an index to ascertain the ovarian activity of these species.

Kidding and lambing frequency:

Goat: The kidding (Table 4.21) in native goats was spread almost round the year except during the months of July and September. The maximum kidding occured during the month of December (46.67%) followed by February (13.33%). The kidding among cross-bred goats was also highest during the month of December (30.0%) followed by February(23.33%). There was no kidding in cross-breds during the month of May and between July to October.

Sheep: The lambing (Table 4.21) was spread almost round the year except during the months of March, July, October and November. The lambing percentages in native sheep was highest during the month of December (56.67%)followed by January (13.33%). In the cross-bred sheep the highest lambing was during the months of February (43.33%)

followed by December (23.33%). There was no lambing among cross-bred sheep between the months of May and August and during October and November.

Kidding and Lambing performances:

Goat: The kidding performance (Table 4.22) indicated that on an average 53.3 percent native goats kidded twice during one year. Out of the total does kidded 26.09 percent does produced twins. Among the progeny born the percentage of male and female was equal. The average number of progeny born per kidding was 1.26. The average kidding percent was 153.3 and number of kids thus calculated per 100 animals per year was 193.3.

Among cross-bred goats the percent animals kidded twice in a year was 6.67 only. Out of the total does kidded only 12.5 percent produced twins. Among the progeny born the percentage of male and female was equal. The average number of progeny born per parturation was 1.125. The average kidding percentage was 106.66 and the number of progeny thus calculated per 100 animal per annum was 119.99.

Sheep: The lambing performance (Table 4.22) indicated that only 6.67 percent of the native sheep lambed twice in one year. Cut of the ewes lambed only 3.1 percent produced twins. Among the progeny born the percentage of male and female was roughly equal. The average progeny born per lambing was 1.029 and the average lambing was 106.66 percent. The number of lambs per 100 ewes per year thus calculated was 109.99 only.

Among cross-bred sheep it was observed that 10.0 percent ewes failed to produce lambs during one year and only 3.7 percent ewes produced twins. Out of the progeny born the proportion of males and female was 42.86 and 57.14 percent, respectively. The number of progeny born per lambing was 1.038 and the average lambing was 89.99 percent. The total number of lambs per 100 animals per year thus calculated was 93.33 only.

<u>Comparison of reproductive performances between species and managemental systems</u>:

<u>Between species</u>:

In general, the age at first parturition was lower in goats by 190 days compared to sheep. Considering the gestation length as 150 days, the tentative age of sexual maturity was also lower in goats approximately by six months. The parturition interval among goats was also lower by 50 days compared to sheep. These above findings indicated the superiority of goats over sheep.

The superiority of goats over sheep was reported earlier by various workers.

<u>Between Management:</u>

In the present experiment, the kidding percentage and number of kids per 100 animal per year was higher by 82.1 and 110.3 percent, respectively in native goats and the kidding percentage in cross-bred goats was higher by 49.07 percent than that of similar animals under conventional managemental system reported by Acharya <u>et</u> <u>al</u>. (1980) and Annual report CSWRI (1978). Similarly, in native sheep, the lambing percentage and number of lambs per 100 animals per year was higher by 29.32 and 33.36 percent, respectively and in cross-bred sheep the trend was also similar and the lambing percentages was higher by 27.14 percent than that of similar animals under conventional system, reported earlier by Acharya et al.(1980) and Annual report CSWRI (1978). Improvement in reproductive performance in the present study as compared to the earlier observations could be attributed due to incentive based management of animals, thus resulted in better grazing, health care and nourishment of animals.

Losses in adult animals:

The adult losses pooled over both the years (Table 4.23) was found to be highest in cross-bred sheep (16.6%), followed by native goat (10%), cross-bred goat (6.6%) and none in native sheep. About 60% of the losses were due to predation and the rest 40% mortality losses were due to clinical complications (Nephritis, Septicaemia and Dystokia).

The above losses in native and cross-bred goats were somewhat higher than that reported by Acharya et al.(1980) and AICRP, Goat project, CSWRI (1981) where the losses were 7.2 and 3.1%, respectively. This could be explained by the fact that the latter reports were based on a larger population samples. The losses among cross-bred sheep were comparable with those animals (13.7%) under conventional farming system managed at the Central Sheep and Wool Research Institute, Avikanagar (Annual report, 1976).

Losses in young animals:

The losses among young animals (Table 4.26) was lower among kids both during pre-weaning (0-3 months) and post-weaning (3-6 months) compared to lambs.

Among breeds, both native and cross-bred kids had almost similar rates of mortality during both the pre-weaning (3.5 Vs. 2.8%) and post-weaning ages (5.4 Vs 5.7%). In lambs the mortality was higher in cross-breds both during pre-weaning (14.3 Vs 12.1%) and post-weaning (12.5 Vs 3.5%) than the natives.

In yearlings (6-12 months of age) the loss was 3.7% only in the native goats which was exclusively due to predation.

The losses in the present study which was mainly due to predation could be attributed to the un dulated topography of the range land under study where the predators get an opportuning to hide themselves.

Causes of adult and young losses:

The major cause of adult losses (Table 4.24 and 4.27) both in sheep and goat was predation (60%), followed by septicaemia (20%). In lambs and kids it was also predation (62%) followed by non-specific reasons (14.3%).

Seasonal distribution of adult and young losses:

Seasonal distribution of adult (Table 4.26) and young (Table 4.28) losses indicated higher losses during summer (April-June)

(40%) in adults and during summer and winter (38% each) among young ones. The adult losses during summer were exclusively due to predation. In young ones, the losses due to predation during summer were 62.5%. Higher losses due to predation in grazing area during summer were also reported by Mathur et al.(1982). This is due to the undulated topography of the study area providing better scope for the predators to hide and kill the animals while grazing.

NUTRITIONAL STATUS DURING DIFFERENT PERIOD

Pasture composition and its nutritive value:

The results of the chemical composition of the pasture used by native and cross-bred sheep and goat during different period in terms of DCP, TDN and DE and the physical environment as THSI has been presented in Table 4.29. It was observed that the nutritive value of pasture varied with the changes of physical environment.

The overall nutritive value expressed as DCP, TDN and DE (Table 4.30) indicated that during summer with elevated THSI (84.969) the digestible nutrients available from the pasture were lowest, having DCP 2.48%, TDN 33.04% and DE 1.33 Kcal/gm. During winter with lowest THSI (56.51) the nutritive value of pasture was highest having 5.72% DCP, 2.1 Kcal/gm DE. Although the TDN was not the highest during winter (39.5 $\pm$ 2.06%) but it remained above the average value (38.45 $\pm$ 1.5%). During autumn, the ground and top vegetation remained in peak growth and provided 4.2% DCP, 40.72% TDN and 2.08 Kcal/gm DE. During spring the leaves of Mytenus emarginatus together with some ground vegetation provided 2.84% DCP, 40.51% TDN and 1.53 Kcal/gm DE. The nutritive values both during autumn and spring season were higher than those of summer season.

Low digestibility of feed/fodders with rise in temperature was also observed by Mc Dowell (1972 b), Bhattacharya and Hussain (1974) and Karim et al.(1982).

Pasture consumption:

Goat: The dry matter intake (Table 4.31) expressed on percent body weight in native goats ranged between 2.76-3.66%, highest being during summer (June). The dry matter intake expressed on the basis of metabolic body weight ranged between 68.01-85.88 g/kg and the highest value was during summer.

In case of cross-bred goats the dry matter intake on percent body weight ranged between 3.01 - 3.53 and the highest was during autumn (September). When expressed on metabolic body weight it ranged between 71.14-85.60 g/kg and the highest intake was also during autumn (September).

Higher dry matter intake among native goats during summer (June) are in contrast to the earlier reports by Mc Dowell (1972b) and Bhattacharya and Hussain (1974) indicating that higher ambient temperature depresses the feed intake. Possible reason for this present findings could be due to the fact that, the natives being more acclimatised to the local climate tend to consume more of low quality feed during summer when the THSI was higher in order to derive their nutrient requirement.

In general, the dry matter intake of goats was 3.21% of their body weight corresponding to 77.69 gm/kg metabolic body weight (Table 4.32). Similar dry matter intake by goats was reported by Ali et al.(1981) and Singh and Bhatia (1982) which was 3.24 and 3.39% of body weight, respectively. Dry matter intake as kg metabolic body weight was reported 80.32 $\pm$ 2.36 g for stall-fed kids maintained on cowpea fodder based feed by Singh (1979).

Sheep: The dry matter intake among native sheep (Table 4.31) ranged between 2.86-3.57% of their body weight and was highest in summer (June). When expressed on kg metabolic body weight it ranged between 66.77-81.45 g and was also highest during summer.

In cross-bred sheep it ranged between 3.05-3.39% of their body weight and was highest during winter (December). When it was expressed on kg metabolic body weight it ranged between 71.48-78.33g.

Higher dry matter intake among natives during summer with higher THSI are in contrast to the earlier reports as mentioned for goats and the possible reasons could be the same.

In general, the dry matter intake of sheep was 3.17% of their body weight corresponding to 74.01 g/kg metabolic weight (Table 4.32). The dry matter intake in grazing sheep as estimated by lignin ratio technique was reported to be 2.53 to 3.21% of their body weight by Cook et al.(1962). The intake per kg metabolic body weight by sheep was reported to be 51.7 - 88.2 g by Cook and Harris (1951), 65.7-88.3 g by Cook et al.(1962), 75.9 g by Pfander(1970), 30-94 g by Moore and Mott (1973). Cardova et al.(1978) reported that the dry matter intake of grazing livestock ranged between 40-90 g per kg metabolic body weight. Wide range in the reported values are due to the difference in pasture conditions and stage of maturity of the fodder plants.

Nutrient digestibility:

The nutrient digestibility for both native and cross-bred sheep and goat (Table 4.32 and Appendix -I) recorded apparently low dry matter digestibility. Use of chromic oxide for estimating faecal output gives on overestimation of faecal output to the extent of 11-24% as reported by Connon et al.(1963), Lesperance and Bohman (1963), Theurer (1969), Wheeler (1962) and thereby the dry matter digestibility. Since, results varied between the studies where chromic oxide was used as external indicator for estimating faecal output, they may not be compared between different trials at different time/place/condition/analytical condition/persons engaged in analysis as suggested by Raleigh et al.(1980). These results are, therefore, compared on a comparative basis instead of absolute basis.

However, in general, the goats were found better digester of fiber (43.11 Vs 38.73%), crude protein (38.5 Vs 35.34%) and nitrogen free extract (40.79 Vs 38.94%) than sheep (Table 4.33).

Higher crude fiber digestibility by goats was also reported by Hussain (1960) Mia *et al.*(1960 a,b) Gihad (1976) Hog (1976) Sharma and Rajora (1977) and Devendra (1978).

Nutrient availability:

Goat: The overall nutrient availability per kg metabolic body weight (Table 4.31 and 4.32) in native goat in terms of DCP was 3.38 g,TDN 32.09 g and DE 130.9 Kcal, respectively. In cross-bred goat the availability of DCP was 3.02 g, TDN 31.52 g and DE 138.69 Kcal,respectively.

The DCP requirement per kg metabolic body weight for goat was reported 2.85 g and 2.5 g by Singh and Sengar (1970) and Majumdar (1960), respectively and the DE requirement was 134.75 Kcal by Singh and Sengar (1970).

In the present study, neither the native nor the cross-bred goat could derive optimum DCP from the pasture during June. In addition, the cross-bred goats failed to obtain optimum amount of DCP during March also.

Sheep: The nutrient availability per kg metabolic body weight for native sheep (Table 4.31 and 4.32) in term of DCP was 2.44 g,TDN 26.76 g and DE 129.89 Kcal, respectively. In cross-bred sheep the availability of DCP was 2.63 g, TDN 25.81 g and DE 129.84 Kcal, respectively.

The DCP requirement for maintenance of an adult sheep has been estimated by Patnayak (1981) to be 3.127 g per kg metabolic body weight. Taking this as standard, it was seen that the pasture failed to meet the requirement of DCP in case of native and cross-bred sheep in the months except during December.

RELATIVE ECONOMICS

The income through sale proceed of milk, wool, surplus animals, hide and manure over both the years and assets at the end of second year (Table 4.34) indicated that the income through native goat was Rs. 7051.87 only followed by Rs. 3684.50 in cross-bred goat, Rs. 2575.10 in native sheep and Rs. 2297.69 in cross-bred sheep, respectively. With respect to species the income from goat was 120.3 percent more than that from sheep. Among the breeds, income through native goat was higher than cross bred goat by 91.4% and the native sheep over its cross-bred by 12.1 percent.

The higher income through goats over sheep (Table 4.35) may be due to sale of more male off-springs at six months of age (36 Vs 14) and they were having higher body weights than the lambs (652.1 Vs 225.4 kg). The adult surplus animals that were culled fetched more price from goats because of their heavier body weights (348.0 kg for goats and 316.0 kg for sheep). The assets in terms of number of young animals (37 kids and 28 lambs)fetched higher market value for goats. Although, the income through the sale of greasy fleece (Rs.814.19) of sheep was higher compared to the sale of milk from goats (Rs. 658.37), but this marginal difference of Rs. 155.82 did not overcome the higher income obtained from goats through rest of the items. In both the species the income from natives were higher than their corresponding cross-breds (Table 4.34, 4.35), mostly due to the similar reasons mentioned earlier for sheep and goat, being more adaptive to the local climatic conditions.

The expenditure for maintenance and upkeep of animals in terms of medicine (Preventive and curative), mineral bricks, replacement of animals (required to keep breedable flock strength constant in each group) and the miscellaneous expenditure (day to day need) pooled over both the years (Table 4.36) indicated higher expenditure on sheep (Rs.1763.07) than on goats (Rs.965.79) by 82 percent. This was mostly due to higher expenditure incurred for medicines and replacement of animals in sheep (Rs.1442.37) compared to that in goats (Rs. 775.79).

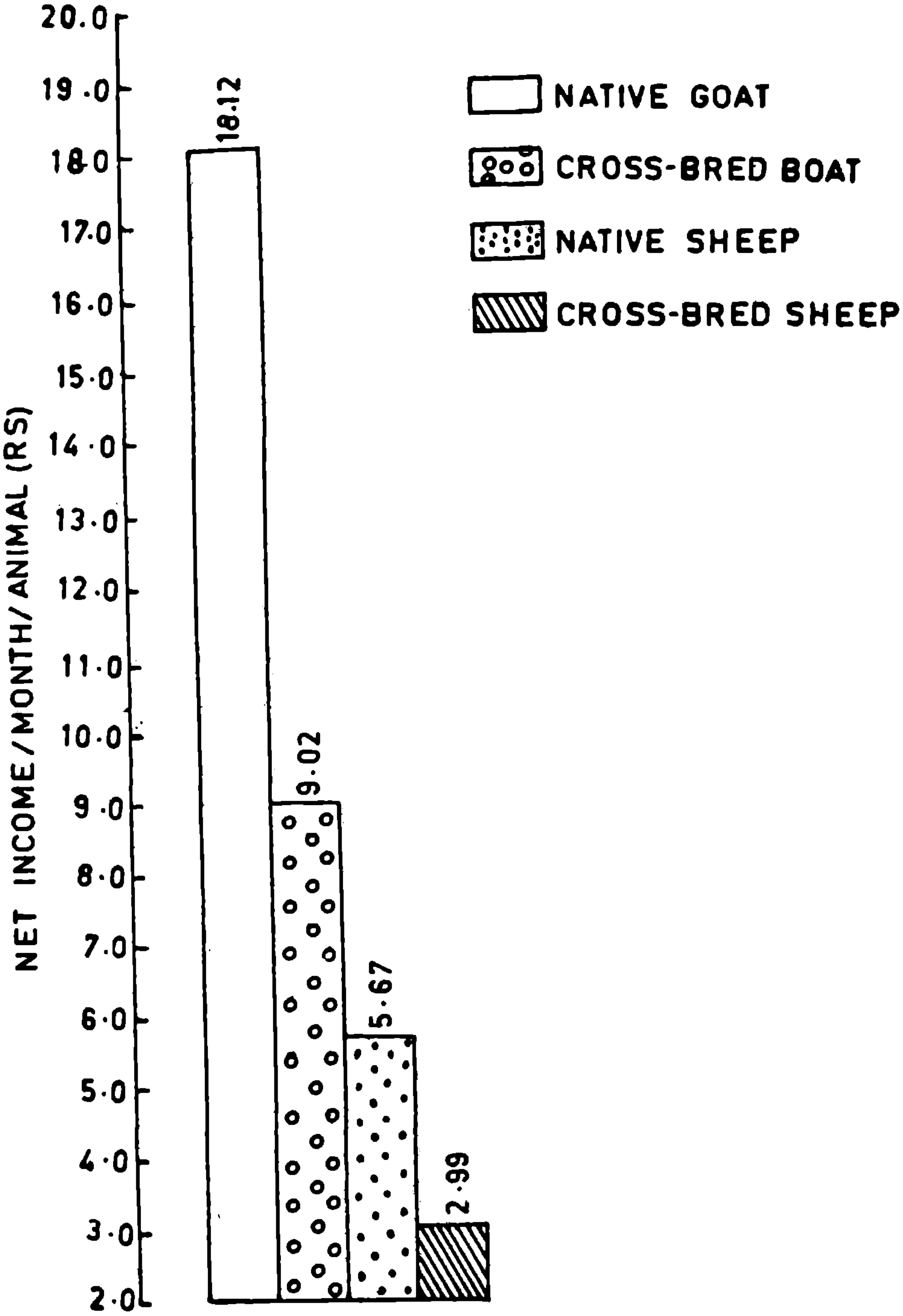
Among the breeds, the expenditure on native goat was slightly higher (Rs.529.26) than on cross-bred goat (Rs.436.53). This may be due to increased expenditure mostly on curative medicine (Rs.224.00 Vs Rs.168.37) for maintenance of higher number of young goats in natives compared to cross-breds. On the other hand the expenditure on cross-bred sheep was higher (Rs.1219.81) than native sheep (Rs.534.25) by 128.3 percent. This may due to higher expenditure on curative medicine (Rs.347.55 Vs 275.70) and replacement of animals for maintaining the breedable flock strength constant (Rs.630.00 Vs Rs.45.00). These observations would reflect that rearing of native sheep is more profitable than the cross-bred sheep. But considering the fact that three cross-bred sheep were predated and none in the native sheep, the comparison is questionable.

Predation is an avoidable loss and had it been avoided by managemental efforts, the economic returns from native and cross-bred sheep would have been similar (Table 4.38).

The net income/animal/month calculated on the basis of sale proceeds and assets as revenue and amount spent on maintenance and upkeep of animals as expenditure (Table 4.37 and Fig.5) over two years indicated superiority of goats (Rs. 13.57) over sheep (Rs. 4.33) by 213.4 percent which may be due to higher fecundity, low mortality and less expenditure for maintenance and upkeep among goats compared to sheep. The profitability of goats over sheep was also reported earlier by Abid (1970), Cook (1970), Acharya and Patnayak (1974), Wahid (1975), Devendra (1978), Ghosh and Khan (1981) and Swain et al.(1982 b). Similar was the trend between native and cross-breds and the net return per animals per month in native goat (Rs. 18.12) was higher than cross-bred goat (Rs. 9.02) by 101 percent and native sheep (Rs. 5.62) over cross-bred sheep(2.99) by 89.6 percent. The higher returns from natives may be due to their better adaptability to the local climatic conditions thereby incurring less expenditure on maintenance and upkeep, and higher return through sale proceeds of different items.

Considering the net income/animal/month from native goat as 100, the proportionate income thus calculated was 49.78, 31.29 and 16.50 from the cross-bred goat, native sheep and cross-bred sheep, respectively.

FIG.5 RELATIVE ECONOMICS (RS)



Economics of sheep and goat under different managemental system:

The economics based on the productivity of 30 native (Malpura) sheep and 30 native goats with one breeding males from each of the two species under natural degraded range land over a period of three years at Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) through conventional managemental system by Acharya et al.(1980) indicated average net return of Rs.690.49 fluid cash per year after paying 10% interest on the loan incurred for the non-recurring. expenditures at the begining, repaying 10% of the loan every year and meeting expenditure on maintenance and upkeep of the animals. The differences between asset and liabilities after three years provided an additional income of Rs. 1104.66 per year, thereby raising the total income to Rs. 1795.15 per year. When the total income was apportioned between sheep and goat it was Rs.0.03/sheep and Rs. 4.91/goat/month. Under the present incentive based managemental system the net income from similar native sheep and goat under similar range land was Rs. 5.67/sheep and Rs.18.12/goat/month, thus making the average income in to a ratio of 1:4.77 (Rs.2.49 Vs 11.89). The difference may be attributed mainly to the human interference under conventional farm managemental system where the experiments are conducted through noncomitted, regularly paid workers involving lot of expenditure Vs. personal attention including more grazing hours in the cooler parts of the day in the incentive based managemental system.

Table 4.1: Surface fodder resources

Sl.No.	Botanical composition	Percent cover	Percent of total cover
1.	*Aristida adscensionis*	1.64	38.317
2.	*Perotis hordeiformis*	0.91	21.261
3.	*Eragrostic ciliaris*	0.48	11.214
4.	*Indigofera cardifolia*	0.25	5.841
5.	*Borehvia hispida*	0.14	3.271
6.	*Borreria diffusa*	0.11	2.570
7.	*Polycarpia corymbosa*	0.09	2.102
8.	*Cenchrus biflorus*	0.07	1.635
9.	*Zornia diphylla*	0.05	1.168
10.	*Eragrostis tremula*	0.03	0.701
11.	*Xanthium strumarium*	0.02	0.467
12.	Others (unidentified)	0.49	11.448
	Total cover	4.28	

Dry matter yield from surface fodder = 8.65 Q/ha

Total dry matter yield from surface fodder from 60 acres - = 207.6 Qtls.

Table 4.2: Top feed resources

S.No.	Botanical composition	No.of trees/ shrubs/ha	Percent on total population
1.	*Acacia senegal*	288	58.299
2.	*Maytenus emerginatus*	62	12.550
3.	*Lycium barbarum*	54	10.931
4.	*Grewia flarascence*	32	6.477
5.	*Grewia tenax*	22	4.453
6.	*Cummifora mukul*	20	4.048
7.	*Leptadonia phyrotechnica*	10	2.024
8.	*Bauhunia perpuria*	6	1.214

Dry matter yield from top feed resources = 6.2 Q/ha

Total dry matter yield from top feed from 60 acres - = 148.8 Qtls.

Table 4.3: Grazing behaviour of sheep and goat with reference to distance travelled and physical environment(THSI) and body biometry

	Native goat	Cross-bred goat	Native sheep	Cross-bred sheep
Av. THSI(for 3 days under study)	73.347 ± 0.561 (3)	73.347 ± 0.561 (3)	67.215 ± 1.077 (3)	67.215 ± 1.077 (3)
Av.Foot step (cm)	48.07 ± 0.147 (200)	48.06 ± 0.177 (200)	38.77 ± 0.169 (200)	38.06 ± 0.176 (200)
Av.Distance travelled (km)/day	14.784 ± 0.384 (3)	13.824 ± 0.222 (3)	10.625 ± 2.080 (3)	9.708 ± 0.979 (3)
Height at wither (cm)	81.0	80.0	65.0	63.0
Heart girth(cm)	77.0	76.0	72.0	71.0
Body length(cm)	74.0	70.0	65.0	62.0
Av.No. of footsteps/day	30755.15	28764.00	27405.20	25507.10
Species average	29759.7		26463.3	

$$THSI = \frac{0.75S(THI \text{ at } 3\text{ PM}) + (24-0.75S)THI \text{ at } 9\text{ AM}}{24}$$

Where $THI = 0.72\ (C_{dbt} + C_{wbt})\ 40.6$

C_{dbt} = dry bulb temperature °C

C_{wbt} = wet bulb temperature °C

S = hours of day light

(Figures in the parenthesis indicates the number of observations)

Table 4.4: Average foot step and height of sheep and goat

Breed	Av.foot step (cm)	Height at whither (cm)	Factor	Angle of movement (degree)
Native goat	48.07 $\pm$ 0.147 (200)	81.0	0.59345 $\pm$ 0.0019 (200)	34.003
Cross-bred goat	48.06 $\pm$ 0.177 (200)	80.0	0.60091 $\pm$ 0.0019 (200)	34.420
Native sheep	38.77 $\pm$ 0.169 (200)	65.0	0.59638 $\pm$ 0.0026 (200)	34.175
Cross-bred sheep	38.06 $\pm$ 0.176 (200)	63.0	0.60409 $\pm$ 0.0028 (200)	34.614
Goats (N + C)	48.065 $\pm$ 0.115 (400)	80.5	0.59718 $\pm$ 0.0014 (400)	34.212 $\pm$ 0.2085 (2)
Sheep (N + C)	38.415 $\pm$ 0.122 (400)	64.0	0.60024 $\pm$ 0.0019 (400)	34.395 $\pm$ 0.2195 (2)
Average	43.24 $\pm$ 0.084 (800)	72.25	0.59871 $\pm$ 0.0012 (800)	34.30 $\pm$ 0.134 (4)

(Figures in the parenthesis indicate the number of observations)

Table 4.5: Influence of physical environment (THSI) on distance travelled

Species	THSI	Distance travelled /day(Km)	'r' value
	72.300	14.400	
Native Goat	73.519	15.552	
	74.222	14.400	
			-0.1734
	72.300	14.208	
Cross-bred goat	73.519	13.824	
	74.222	13.440	
Average	73.347 ± 0.355 (6)	14.304 ± 0.292 (6)	
Native sheep	66.484	10.000	
	65.825	14.500	
	69.336	7.375	
Cross-bred sheep	66.484	9.500	-0.8172*
	65.825	11.500	
	69.336	8.125	
Average	67.215 ± 0.681 (6)	10.166 ± 1.049 (6)	

* $\angle 0.05$

Adult body weight of sheep and goat during different months of the year (kg)

Table 4.6: Body weight of native and cross-bred goats

Month	Native goat			Cross-bred goat		
	I yr.	II yr.	Pooled	I yr.	II yr.	Pooled
Jan	36.0±2.90 (2)	34.3±5.55 (3)	35.0±3.67 (5)	22.5±1.23 (6)	34.8±1.44 (9)	29.9±0.99 (15)
Feb	35.0±0.00 (2)	35.1±1.86 (10)	35.1±1.61 (12)	26.1±1.49 (5)	33.8±1.17 (9)	31.1±0.92 (14)
Mar	33.4±1.11 (5)	35.3±3.21 (5)	34.5±1.69 (10)	27.4±1.36 (6)	33.3±1.07 (9)	30.9±0.84 (15)
Apr	33.2±1.43 (7)	34.8±3.01 (5)	33.9±1.49 (12)	27.4±0.95 (9)	33.6±0.92 (13)	31.1±0.67 (22)
May	33.8±1.10 (9)	32.9±1.82 (8)	33.4±1.03 (17)	27.8±0.96 (12)	32.5±1.02 (14)	30.3±0.71 (26)
June	34.7±0.99 (12)	32.9±1.58 (8)	34.0±0.86 (20)	27.4±1.03 (14)	32.6±0.82 (14)	30.0±0.66 (28)
July	32.8±0.88 (13)	31.5±1.82 (5)	32.4±0.81 (18)	25.9±0.89 (15)	31.4±0.82 (12)	28.3±0.61 (27)
Aug	32.9±1.19 (10)	32.7±1.41 (8)	32.8±0.91 (18)	27.8±0.97 (15)	32.9±0.88 (12)	30.1±0.67 (27)
Sept	34.2±2.71 (4)	34.7±4.34 (3)	34.4±2.39 (7)	28.6±0.96 (9)	34.6±1.57 (5)	30.7±0.83 (14)
Oct	38.0±3.01 (2)	36.5±4.17 (3)	37.1±2.86 (5)	31.5±1.06 (9)	38.4±1.33 (4)	33.6±0.85 (13)
Nov	39.1±2.91 (4)	38.4±4.28 (3)	38.8±2.46 (7)	34.8±2.31 (5)	39.8±1.51 (3)	36.7±1.58 (8)
Dec	35.5±12.53 (2)	39.3±4.34 (3)	37.8±5.33 (5)	36.6±1.43 (10)	38.4±2.02 (3)	37.0±1.21 (13)

(Figures in the parenthesis indicates the number of observations)

Table 4.7: Changes in adult body weight of goats during different months

Month	Native goat		Cross-bred goat	
	Magnitude (%)	Av.No.of* animals available	Magnitude (%)	Av.No.of * animals available
Jan - Feb	+0.29	28.75	+4.00	24.50
Feb - Mar	-1.71	32.20	-0.64	27.25
Mar- Apr	-1.74	34.75	+0.70	28.00
Apr - May	-1.47	35.50	-2.57	27.25
May - June	+1.80	35.25	-0.99	25.25
June-July	-4.70	33.75	-5.67	22.75
July- Aug	+1.20	35.00	+6.40	20.75
Aug - Sept	+4.87	29.00	+2.00	20.50
Sept- Oct	+7.85	26.75	+9.50	18.75
Oct - Nov	+4.85	28.25	+9.20	20.25
Nov - Dec	-2.58	33.75	+0.82	24.25

* The average number of animals includes adults as well as their followers

Table 4.8: Body weight of native and cross-bred sheep

Month	Native sheep			Cross-bred sheep		
	1 yr.	II yr.	Pooled	1 yr.	II yr.	Pooled
Jan	30.3±1.16 (7)	26.7±1.10 (8)	28.4±0.79 (15)	32.2±1.94 (4)	29.1±1.51 (8)	30.1±1.20 (12)
Feb	30.6±1.08 (5)	27.0±1.19 (10)	28.2±0.88 (15)	39.2±0.60 (2)	29.3±1.55 (8)	31.3±1.30 (10)
Mar	27.9±1.24 (7)	26.8±0.79 (13)	27.2±0.67 (20)	38.6±0.00 (1)	29.7±1.57 (9)	30.6±1.49 (10)
Apr	27.1±1.06 (8)	26.7±0.69 (12)	26.9±0.59 (20)	34.2±1.87 (14)	28.2±1.30 (9)	31.9±1.07 (23)
May	26.8±0.88 (9)	26.6±0.76 (13)	26.7±0.58 (22)	31.7±1.34 (8)	28.0±0.72 (13)	29.4±0.67 (21)
June	24.5±0.65 (9)	26.7±0.82 (13)	25.8±0.55 (22)	28.3±0.91 (9)	28.4±0.67 (14)	28.4±0.54 (23)
July	22.3±0.62 (12)	27.4±0.77 (11)	24.7±0.49 (23)	25.8±0.84 (9)	28.2±0.56 (13)	27.2±4.48 (22)
Aug	25.1±0.65 (12)	27.9±0.59 (10)	26.4±0.44 (22)	28.4±0.75 (15)	31.9±0.68 (13)	30.0±0.51 (28)
Sept	27.6±0.59 (11)	29.1±0.50 (10)	28.3±0.39 (21)	31.1±0.84 (15)	33.7±0.88 (12)	32.3±0.61 (27)
Oct	30.6±1.22 (8)	30.3±1.70 (2)	30.5±1.05 (10)	33.9±0.90 (14)	33.8±1.00 (10)	33.9±0.67 (24)
Nov	30.0±1.28 (9)	30.0±4.01 (2)	30.0±1.23 (11)	33.0±0.98 (13)	34.8±2.13 (5)	33.5±0.92 (18)
Dec	29.1±1.10 (8)	29.0±2.80 (3)	29.1±1.08 (11)	32.8±1.37 (9)	31.6±2.34 (6)	32.3±1.24 (15)

(Figures in the parenthesis indicates the number of observations)

Table 4.9: Changes in adult body weight of sheep during different months

Month	Native sheep		Cross-bred sheep	
	Magnitude (%)	Av.No.of * animals available	Magnitude (%)	Av.No.of * animals available
Jan - Feb	-0.70	22.00	+3.98	21.75
Feb - Mar	-4.25	22.00	-2.24	25.75
Mar - Apr	-1.10	22.75	+4.25	26.50
Apr - May	-0.74	23.75	-7.85	26.50
May - June	-3.37	24.25	-3.40	25.50
June- July	-4.26	23.50	-4.23	24.00
July- Aug	+6.88	22.75	+10.29	22.50
Aug - Sept	+7.19	23.00	+7.66	21.50
Sept-Oct	+7.77	22.50	+4.95	20.25
Oct - Nov	-1.64	21.75	-1.18	19.00
Nov - Dec	-3.00	24.75	-3.58	21.00
Jan - Apr	-5.28	22.25	+5.98	24.66
Apr - Aug	-1.86	23.56	-5.96	24.63
Aug - Dec	+10.23	23.00	+7.70	20.44

* The average number of animals includes adults as well as their followers

Table 4.10: Co-rrelation between temperature humidity sunshine index (THSI) and adult body weight of sheep and goat

r_{xy1}	$= -0.596^{**}$		
r_{xy_2}	$= -0.4962^{*}$		
r_{xy3}	$= -0.440^{*}$		
r_{xy4}	$= -0.4165^{*}$		
Where	X = Temperature humidity sunshine index (THSI)		
	y1= Body weight of native goat		
	y2=	- do -	cross-bred goat
	y3=	- do -	native sheep
	y4=	- do -	cross-bred sheep

* $P \angle 0.05$ ** $P \angle 0.01$

Body weight of Lambs and Kids at different ages(kg)

Table 4.11: Body weight of native and cross-bred kids

Stage of growth	Sex	Native goat			Cross-bred goat		
		I yr.	II yr.	Pooled	I yr.	II yr.	Pooled
BIRTH	Male	3.33±0.14 (16)	2.88±0.09 (13)	3.13±0.8073 (29)	3.40±0.14 (13)	3.00±0.17 (5)	3.29±0.1123 (18)
	Female	2.89±0.12 (15)	2.44±0.09 (14)	2.67±0.0758 (29)	3.03±0.17 (6)	2.82±0.10 (12)	2.89±0.09 (18)
	Pooled	3.12±0.0927 (31)	2.65±0.0637 (27)	2.80±0.0578* (58)	3.28±0.11 (19)	2.87±0.0863 (17)	3.09±0.0711* (36)
WEANING (90 DAYS)	Male	12.14±0.83 (7)	11.01±0.65 (17)	11.34±0.522 (24)	10.43±0.81 (8)	12.90±1.10 (8)	11.66±0.683 (16)
	Female	10.37±0.98 (7)	9.52±0.75 (17)	9.79±0.605 (24)	9.87±1.94 (3)	10.63±0.96 (8)	10.42±0.866 (11)
	Pooled	11.25±0.642 (14)	10.26±0.496 (34)	10.56±0.3995 (48)	10.28±0.774 (11)	11.76±0.730 (16)	11.15±0.5366 (27)
SIX MONTH	Male	18.08±1.25 (5)	16.99±0.81 (14)	17.278±0.683 (19)	17.10±1.04 (8)	17.89±1.42 (7)	17.47±0.863 (15)
	Female	17.64±0.87 (5)	13.42±0.74 (17)	14.38±0.6106 (22)	16.00±1.53 (3)	16.30±1.25 (6)	16.20±0.983 (9)
	Pooled	17.86±0.761 (10)	15.03±0.546 (31)	15.72±0.4555 (41)	16.80±0.868 (11)	17.16±0.959 (13)	16.99±0.654 (24)
TWELVE MONTH	Female	-	26.80±1.07 (14)			28.60±2.42 (5)	

(Figures in the parenthesis indicate the number of observations)

*P∠0.05

Table 4.12: Body weight of native and cross-bred Lambs

Stage of growth	Sex	Native sheep			Cross-bred sheep		
		I yr.	II yr.	Pooled	I yr.	II yr.	Pooled
BIRTH	Male	2.89±0.16 (19)	2.80±0.28 (7)	2.85±0.15 (17)	3.57±0.17 (6)	3.10±0.23 (6)	3.33±0.1430 (12)
	Female	2.65±0.17 (8)	2.58±0.13 (8)	2.61±0.11 (16)	3.46±0.17 (8)	2.8±0.09 (8)	3.11±0.0925 (16)
	Pooled	2.78±0.1165 (17)	2.68±0.1474 (15)	2.73±0.0927** (33)	3.51±0.1206 (13)	2.93±0.1102 (14)	3.21±0.0816** (28)
WEANING (90 DAYS)	Male	11.20±0.91 (5)	11.20±1.17 (3)	11.20±0.7184 (8)	9.60±0.56 (5)	11.87±2.75 (3)	10.45±1.0373 (8)
	Female	12.20±0.87 (7)	9.67±1.20 (3)	11.44±0.7109 (10)	10.80±0.93 (7)	7.87±0.87 (3)	9.92±0.7147 (10)
	Pooled	11.78±0.6347 (12)	10.43±0.8379 (6)	11.33±0.5082 (18)	10.30±0.5958 (12)	9.87±1.4421 (6)	10.16±0.6073 (18)
SIX MONTH	Male	19.35±1.63 (4)	15.60±1.21 (3)	17.74±1.0779 (7)	16.70±0.88 (6)	-	16.70±0.88 (6)
	Female	15.10±0.63 (6)	16.80±1.99 (4)	15.78±0.8619 (10)	14.40±0.95 (7)	-	14.40±0.95 (7)
	Pooled	16.80±0.7398 (10)	16.28±1.2683 (7)	16.59±0.6734 (17)	15.46±0.6538 (13)	-	15.46±0.6538 (13)
TWELVE MONTH	Female	-	21.15±0.75** (8)			16.80±1.14** (5)	

(Figures in the parenthesis indicate the number of observations)

** $P < 0.01$

Table 4.13: Average daily gain of lambs and kids(gm)

Breed	Sex	Pre-weaning	Post-weaning	6-12 month
Native goat	M	91.22	65.98	-
	F	79.11	51.00	69.00
	P	86.22	37.33	-
Cross-breed goat	M	93.00	64.55	-
	F	83.66	64.22	68.89
	P	89.55	64.89	-
GOAT		87.89	61.11	68.95
Native sheep	M	92.77	72.67	-
	F	98.11	48.22	29.83
	P	95.56	58.44	-
Cross-breed sheep	M	79.11	69.44	-
	F	75.66	49.78	13.33
	P	77.22	58.89	-
SHEEP		86.39	58.67	21.58

Table 4.14: Co-rrelated between THSI and Pre-weaning gain (kg) of lambs and kids

r_{xy1}	= - 0.4815*
r_{xy2}	= - 0.4932*
r_{xy3}	= - 0.4537
r_{xy4}	= - 0.6018*
r_{xy5}	= - 0.0867
r_{xy6}	= - 0.1810
r_{xy7}	= - 0.5040
r_{xy8}	= - 0.2020
Where	x = Average THSI/month to which the lambs/kids were exposed
	y1= Pre-weaning gain of male native kid
	y2= - do - female native kid
	y3= - do - male cross-bred kid
	y4= - do - female cross-bred kid
	y5= - do - male native lamb
	y6= - do - female native lamb
	y7= - do - male cross-bred lamb
	y8= - do - female cross-bred lamb
	* $P < 0.05$

Table 4.15: Milk yield of native and cross-bred goats

Breed	Lactation length(days)	Lactation yield(kg)	Daily average yield (gms)
Native goat	149.62±4.99 (21)	44.87±2.48 (21)	298.350±12.354 (21)
Cross-bred goat	160.47±5.26 (15)	47.82±2.59 (15)	296.636±9.688 (15)

Table 4.16: Average milk yield (kg)/day during different fortnight of post kidding

Breed	Fortnight						
	I	II	III	IV	V	VI	VII
Native goat	0.34±0.02 (22)	0.43±0.02 (22)	0.45±0.02 (22)	0.42±0.02 (22)	0.37±0.02 (22)	0.34±0.02 (22)	0.26±0.02 (22)
Cross-bred goat	0.34±0.02 (15)	0.44±0.03 (15)	0.46±0.02 (15)	0.46±0.02 (15)	0.39±0.02 (15)	0.37±0.02 (15)	0.28±0.03 (15)
	VIII	IX	X	XI	XII	XIII	
Native goat	0.20±0.02 (21)	0.17±0.02 (18)	0.14±0.02 (13)	0.10±0.01 (11)	0.06±0.01 (5)	0.05±0.00 (1)	
Cross-bred goat	0.24±0.03 (15)	0.18±0.02 (15)	0.14±0.02 (13)	0.11±0.02 (11)	0.09±0.02 (6)	0.05±0.00 (4)	

(Figures in the parenthesis indicates the number of observations)

Table 4.17: Average milk yield (gm)during different months of the year (per day basis)

Month	Jan	Feb	Mar	Apr	May	June
Native goat	422.2±40.6 (9)	306.8±36.01 (11)	273.1±10.66 (13)	283.3±35.11 (9)	239.3±30.31 (7)	322.9±43.79 (12)
Cross-bred goat	439.3±20.31 (7)	385.4±25.83 (12)	332.7±31.82 (13)	262.5±40.18 (12)	191.7±33.59 (9)	200.0±24.15 (6)
	July	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Native goat	388.9±56.07 (9)	364.3±16.24 (7)	233.3±21.08 (6)	180.0±18.37 (5)	91.6±16.67 (3)	467.9±27.66 (7)
Cross-bred goat	215.0±77.70 (5)	387.5±37.50 (2)	237.5±12.49 (2)	125.0+0 (2)	200.0±18.26 (6)	485.7±28.27 (7)

Monthly average = Native goat = 298.7
per day basis(gm) Cross-bred goat = 287.69

(Figures in the parenthesis indicates the number of observations)

Wool yield of native and cross-bred sheep

Table 4.18: Wool yield (gms) of adult and young sheep during different clips

	Adult		Average Annual wool yield(kg)	Yield/kg Body weight	Young		
	Spring	Autumn			Yield adj. for 180 days	Yield/kg Body weight	Yield/ 100 hrs.of sunlight
Native sheep	446.00 ± 39.622 (30)	342.758 ± 40.271 (29)	0.772 ± 0.055** (26)	13.884 ± 0.016** (59)	492.41 ± 71.096 (14)	12.447 ± 3.326 (14)	25.66 ± 3.095 (9)
Cross-bred sheep	993.57 ± 67.118** (28)	571.071 ± 51.355** (28)	1.587 ± 0.116** (24)	23.686 ± 1.582** (56)	490.90 ± 57.818 (10)	13.281 ± 4.427 (9)	30.47 ± 3.291 (9)

Note : 1. Adult wool yield during different seasons has been compared between seasons

2. Average wool yield and wool yield per kg body weight (adult and young) has been compared between breeds

** $P \angle 0.01$

(Figures in the parenthesis indicates the number of observations)

Reproductive performances of Sheep and Goat

Table 4.19: Age at first lambing/kidding, body weight(kg) and lambing/kidding intervals (days)

Species	Age at first lambing/kidding (days)	Body weight(kg) at first lambing/kidding	Lambing/kidding intervals(days)
Native goat	458.0±23.00 (8)	28.35±0.819 (8)	299.35±18.75* (26)
Cross-bred goat	449.0±18.24 (3)	28.13±0.94 (3)	388.67±33.29* (15)
Average(N+C) goat	453.5	28.24	344.01
Native sheep	606.0±97.03 (3)	28.20±1.60 (3)	401.71±34.97 (17)
Cross-bred sheep	680.0±10.03 (2)	29.40±1.40 (2)	386.33±47.26 (6)
Average (N+C) sheep	643.0	28.8	394.02

*P∠0.05

(Figures in the parenthesis indicate the number of observations)

Table 4.20: Distribution of tupping frequency over different months

Species	Year	No.of animals lambed/ kidded	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	I	23	-	-	2	-	2	4	5	2	2	5	1	-
Native goat	II	23	6	-	-	-	-	-	9	-	5	2	-	1
	Av.	23	3	-	1	-	1	2	7	1	3.5	3.5	0.5	0.5
Tupping	%		20.0	-	6.67	-	6.67	13.33	46.67	6.67	23.33	23.33	3.33	3.33
	I	16	-	-	-	-	-	6	1	3	3	2	1	-
Cross-bred goat	II	16	2	-	-	-	-	-	8	1	4	1	-	-
	Av.	16	1	-	-	-	-	3	4.5	2	3.4	1.5	0.5	-
Tupping	%		6.67	-	-	-	-	20.0	30.0	13.33	23.33	10.00	3.33	-
	I	17	2	-	1	-	-	-	6	3	1	-	3	1
Native sheep	II	15	-	1	-	-	1	-	-	1	1	-	-	-
	Av.	16	1	0.5	0.5	-	0.5	-	3	2	1	-	1.5	0.5
Tupping	%		6.67	3.33	3.33	-	3.33	-	20.00	13.33	6.67	-	10.00	3.33
	I	14	-	-	-	-	-	-	1	1	8	2	2	-
Cross-bred sheep	II	13	-	-	-	1	-	-	6	-	5	1	-	-
	Av.	13.5	-	-	-	0.5	-	-	3.5	0.5	6.5	1.5	1	-
Tupping	%		-	-	-	3.33	-	-	23.33	3.33	43.33	10.00	6.67	-

Table 4.21: Distribution of lambing/kidding frequency over different months

Species	Year	No.of animals lambed/ kidded	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	I	23	2	2	5	1	-	-	-	2	-	2	4	5
Native goat	II	23	-	5	2	-	1	6	-	-	-	-	-	9
	Av.	23	1	3.5	3.5	0.5	0.5	3	-	1	-	1	2	7
Kidding	%		6.67	23.33	23.33	3.33	3.33	20.00	-	6.67	-	6.67	13.33	46.67
	I	16	3	3	2	1	-	-	-	-	-	-	6	1
Cross-bred goat	II	16	1	4	1	-	-	2	-	-	-	-	-	8
	Av.	16	2	3.5	1.5	0.5	-	1	-	-	-	-	3	4.5
Kidding	%		13.33	23.33	10.00	3.33	-	6.67	-	-	-	-	20.00	30.00
	I	17	3	1	-	3	1	2	-	1	-	-	-	6
Native sheep	II	15	1	1	-	-	-	1	-	-	1	-	-	11
	Av.	16	2	1	-	1.5	0.5	1.5	-	0.5	0.5	-	-	8.5
Lambing	%		13.33	6.67	-	10.00	3.33	10.00	-	3.33	3.33	-	-	56.67
	I	14	1	8	2	2	-	-	-	-	-	-	-	1
Cross-bred sheep	II	13	-	5	1	-	-	-	-	-	1	-	-	6
	Av.	13.5	0.5	6.5	1.5	1.0	-	-	-	-	0.5	-	-	3.5
Lambing	%		3.33	43.33	10.00	6.67	-	-	-	-	3.33	-	-	23.33

Table 4.22: Lambing and kidding performance

Breed	Year	No.of animals lambed/ kidded	No.of progeny born			Sex		No.of progeny/ parturation	Kidding/ Lambing percentage	Av.No.of progeny/100 animals/year
			Single	Twin	Total	Male	Female			
Native goat	I	23	15	8	31	16	15	1.3478	153.333	206.6622
	II	23	19	4	27	13	14	1.1739	153.333	179.9976
	Av.	23	17	6	29	14.5	14.5	1.2608	153.333	193.3299
Cross-bred goat	I	16	13	3	19	13	6	1.1875	106.666	126.665
	II	16	15	1	17	5	12	1.0625	106.666	113.332
	Av.	16	14	2	18	9	9	1.1250	106.666	119.999
Native sheep	I	17	16	1	18	10	8	1.0588	113.333	119.996
	II	15	15	-	15	7	8	1.0000	100.000	100.000
	Av.	16	15.5	0.5	16.5	8.5	8	1.0294	106.666	109.998
Cross-bred sheep	I	14	14	-	14	6	8	1.0000	93.333	93.333
	II	13	13	1	14	6	8	1.0769	86.666	93.331
	Av.	13.5	13.5	0.5	14	6	8	1.0385	89.999	93.332

Losses among adult sheep and goat (%)

Table 4.23: Adult losses (%)

Breed	I yr.	II yr.	Average year (%)
Native goat	6.667	13.333	10.00
Cross-bred goat	13.333	0.00	6.667
Native sheep	0.00	0.00	0.00
Cross-bred sheep	33.33	0.00	16.667

Table 4.24: Causes of adult losses

Breed	No. of animals died due to different causes				
	Predation	Nephritis	Septicaemia	Dystokia	Total
Native goat	2	1	-	-	3
Cross-bred goat	1	-	1	-	2
Native sheep	-	-	-	-	-
Cross-bred sheep	3	-	1	1	5

Table 4.25: Seasonal distribution of adult losses

Cause of mortality	Spring				Summer				Autumn				Winter			
	NG	Cr.G	N.S	Cr.S	NG	Cr.G	NS	Cr.S	NG	Cr.G	NS	Cr.S	NG	Cr.G	NS	Cr.S
Predation	1	-	-	-	-	1	-	3	1	-	-	-	-	-	-	-
Nephritis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Septicaemia	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-
Dystokia	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Note : NG = Native goat
Cr.G = Cross-bred goat
NS = Native sheep
Cr.S = Cross-bred sheep

Spring = January - March
Summer = April - June
Autumn = July - September
Winter = October - December

Losses among young sheep and goat (%)

Table 4.26: Young losses (%)

Brêed	Both sex	Both sex	Only female
	Birth- 3 months	3 - 6 months	between 6-12 months
Native goat	3.45	5.36	3.70
Cross-bred goat	2.78	5.71	0.00
Native sheep	12.12	3.45	0.00
Cross-bred sheep	14.29	12.50	0.00

Table 4.27: Causes of young losses

Breed	No.of animals died due to different causes						
	Predation	Gastro-entritis	Septica-emia	External shock	Still birth	Non-specific	Total
Native goat	5	-	-	1	-	-	6
Cross-bred goat	3	-	-	-	-	-	3
Native sheep	3	1	-	-	1	-	5
Cross-bred sheep	2	-	2	-	-	3	7

Table 4.28: Seasonal distribution of young losses in sheep

Causes of mortality	Spring				Summer				Autumn				Winter			
	NG	CR.G	NS	Cr.S	NG	Cr.G	NS	Cr.S	NG	Cr.G	NS	Cr.S	NG	Cr.G.	NS	Cr.S
Predation	-	-	1	-	-	3	-	2	1	-	-	-	4	-	2	-
Gastroentritis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Septicaemia	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
External shock	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Still birth	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-specific	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-

Note : NG = Native goat
Cr.G= Cross-bred goat
NS = Native sheep
Cr.S= Cross-bred sheep

Spring = January - March
Summer = April - June
Autumn = July - September
Winter = October-December

Table 4.29: Influence of THSI on fodder intake and its nutritive value in sheep and goat

Season	THSI	Native goat				Cross-bred goat			
		Intake (% body weight)	Nutritive value of fodder			Intake (% body weight)	Nutritive value of fodder		
			DCP(%)	TDN(%)	DE(Kcal/gm)		DCP(%)	TDN(%)	DE(Kcal/gm)
Spring(March)	64.429	3.260	3.61	50.19	1.524	3.01	3.11	46.81	1.297
Summer(June)	84.969	3.660	2.77	30.28	1.443	3.22	2.74	26.099	1.443
Autumn(Sept.)	76.837	2.760	4.85	42.57	1.971	3.53	3.88	44.98	2.074
Winter(Dec.)	56.506	2.997	6.75	40.35	2.172	3.21	5.73	44.07	2.285
			Native sheep				Cross-bred sheep		
Spring(March)	64.429	2.87	2.53	34.66	1.679	3.05	2.12	30.36	1.630
Summer(June)	84.969	3.57	1.98	37.12	1.371	3.36	2.44	38.64	1.051
Autumn(Sept.)	76.837	3.00	4.20	40.10	2.102	3.26	3.87	35.24	2.172
Winter(Dec.)	56.506	2.86	4.97	39.60	2.100	3.39	5.41	34.07	1.837

Table 4.30: Influence of THSI on overall nutritive value of fodder during different season

Season	THSI	DCP(%)	TDN(%)	DE(Kcal/gm)
Spring (March)	64.429	2.84 ± 0.327 (4)	40.51 ± 4.749 (4)	1.53 ± 0.085 (4)
Summer (June)	84.969	2.48 ± 0.183 (4)	33.04 ± 2.941 (4)	1.33 ± 0.094 (4)
Autumn(September)	76.837	4.20 ± 0.229 (4)	40.72 ± 2.081 (4)	2.08 ± 0.042 (4)
Winter(December)	56.506	5.72 ± 0.379 (4)	39.52 ± 2.064 (4)	2.10 ± 0.095 (4)
Average	70.685±6.338 (4)	3.81 ± 0.145 (16)	38.45 ± 1.577 (16)	1.76 ± 0.041 (16)

(Figures in the parenthesis indicates number of observations)

Table 4.31: Nutritional status of sheep and goat during different period

Season	Av.body weight (kg)	Intake		Co-efficient of digestion(%)		Nutritive value of fodder			Available nutrients/kg metabolic body weight		
		% body weight	g/kg metabolic weight(wo.75)	DM	GE	DCP(%)	TDN(%)	DE (Kcal/g)	DCP(g)	TDN(g)	DE (Kcal)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						For native goat					
Spring(March)	42.10	3.26	83.12	36.30	34.75	3.61	50.19	1.524	3.00	41.71	126.70
Summer(June)	31.10	3.66	85.88	21.22	27.70	2.77	30.28	1.443	2.38	27.14	123.93
Autumn(Sept.)	36.80	2.76	68.01	37.60	37.54	4.85	42.57	1.971	3.03	28.95	134.04
Winter(Dec.)	40.15	2.997	75.74	33.11	39.17	6.75	40.35	2.172	5.11	30.56	139.02
						For cross-bred goat					
Spring(March)	34.90	3.01	73.26	32.80	29.56	3.11	46.81	1.297	2.28	34.29	94.98
Summer(June)	23.70	3.22	71.14	17.67	27.70	2.74	26.10	1.443	1.95	18.57	102.65
Autumn(Sept.)	34.30	3.53	85.60	40.56	39.51	3.88	44.98	2.074	3.33	38.50	177.54
Winter(Dec.)	36.40	3.21	78.74	37.44	41.44	5.73	44.70	2.285	4.52	34.70	179.60

(Contd...)

Table 4.31 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					For native sheep						
Spring(March)	29.15	2.87	66.77	28.52	38.82	2.53	34.66	1.679	1.69	23.14	112.80
Summer(June)	27.05	3.57	81.45	21.74	29.94	1.98	37.12	1.371	1.61	27.76	111.59
Autumn(Sept.)	31.20	3.00	70.91	37.60	42.86	4.20	40.10	2.102	2.97	28.43	149.05
Winter(Dec.)	36.00	2.86	69.93	32.88	39.09	4.97	39.60	2.090	3.47	27.69	146.14
					For cross-bred sheep						
Spring(March)	29.95	3.05	71.48	25.35	37.45	2.12	30.36	1.630	1.52	21.70	116.49
Summer(June)	29.60	3.36	78.33	23.94	22.95	2.44	38.64	1.051	1.91	28.46	96.35
Autumn(Sept.)	27.95	3.26	75.14	39.21	44.29	3.81	35.24	2.172	2.86	26.48	163.21
Winter(Dec.)	27.90	3.39	78.01	27.66	34.36	5.41	34.07	1.837	4.22	26.58	143.29

Table 4.32: Overall comparison of intake, digestibility and available nutrients for sheep and goat

Breed/Breed cross	Intake		Co-efficient of digestion (%)						Available nutrients/kg metabolic body weight(w °75)		
	% body weight	g/kg metabolic weight	DM	CP	EF	CF	NFE	GE	DCP(g)	TDN(g)	DE (Kcal)
Native goat	3.169	78.19	32.06	41.40	40.43	44.15	40.94	34.79	3.38	32.09	130.92
Cross-bred goat	3.242	77.19	32.12	35.74	36.77	42.07	40.64	34.48	3.02	31.52	138.69
Native sheep	3.075	72.27	30.19	35.34	36.85	40.57	41.17	37.68	2.44	26.76	129.89
Cross-bred sheep	3.265	75.74	29.04	35.33	40.01	36.89	36.70	34.76	2.63	25.81	129.84
Goat (N+C)	3.21	77.69	32.09	38.57	38.60	43.11	40.79	34.64	3.20	31.81	134.81
Sheep(N+C)	3.17	74.01	29.62	35.34	38.43	38.73	38.94	36.22	2.54	26.29	129.87

Table 4.33: Temperature Humidity Sunshine Index(THSI) for the year 1980

Month	DBT °C		WBT °C		Hours of sunshine	THI		THSI
	9AM	3PM	9AM	3PM		9AM	3PM	
Jan	-	-	-	-	-	-	-	-
Feb	13.5	26.6	8.7	13.9	9.9	56.584	69.760	60.660
Mar	16.1	29.8	10.9	15.8	9.6	60.040	73.432	64.058
Apr	26.7	38.7	15.7	19.8	10.8	71.128	82.720	75.040
May	30.4	40.2	20.3	21.7	10.6	77.104	85.168	79.775
June	30.1	36.9	23.3	24.8	7.75	79.048	85.024	80.495
July	26.8	31.1	24.3	25.1	5.49	77.392	81.064	78.022
Aug	27.0	32.7	23.7	25.2	8.32	77.104	82.288	78.452
Sep	25.7	34.5	21.4	23.2	9.73	74.512	82.144	76.833
Oct	22.1	34.4	16.9	21.5	10.05	68.680	80.848	72.502
Nov	14.8	27.5	12.2	18.7	9.55	60.040	73.860	64.164
Dec	9.3	22.6	7.3	13.8	7.88	52.550	66.810	56.061

(Contd..)

Table 4.33(cont.): Temperature Humidity Sunshine Index (THSI) for the year 1981

Month	DBT °C		WBT °C		Hours of sunshine	THI		THSI
	9AM	3PM	9AM	3PM		9AM	3PM	
Jan	9.2	21.2	7.6	12.4	9.07	52.69	64.79	56.119
Feb	11.5	26.5	7.8	13.9	9.85	54.49	69.68	59.165
Mar	16.6	29.1	12.1	16.7	8.24	61.26	73.57	64.429
Apr	24.4	37.4	14.5	18.4	10.47	68.61	80.77	72.588
May	29.1	40.1	21.2	25.0	10.96	76.81	87.47	80.461
June	32.1	39.3	26.4	29.7	9.52	82.72	90.28	84.969
July	26.6	31.6	24.1	24.7	8.13	77.10	81.13	78.123
Aug	25.4	31.0	23.3	24.7	6.32	75.66	80.70	76.655
Sep	25.4	33.5	22.1	23.5	9.53	74.80	81.64	76.837
Oct	20.9	32.0	16.4	19.1	9.88	67.45	77.39	70.518
Nov	13.0	25.2	11.3	16.0	10.31	58.10	70.264	62.016
Dec	8.6	22.5	6.9	15.3	9.46	51.76	67.816	56.506

$$\text{THSI} = \frac{0.75\ \text{S (THI at 3 PM)} + (24-0.75\ \text{S}) \times \text{THI at 9 AM}}{24}$$

Where THI $= 0.72(C_{dbt} + C_{wbt}) + 40.6$

dbt = dry bulb temperature C°

wbt = wet bulb temperature C°

S = Hours of sunshine

Relative economics

Table 4.34: Income through sale proceeds of different items (Rs.)

Items	I yr.				II yr.				Total			
	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep
Milk	213.37	16.50	-	-	213.50	215.00	-	-	426.87	231.50	-	-
Wool	-	-	135.00	233.44	-	-	125.50	320.25	-	-	260.50	553.69
Male Hoggets	932.00	729.00	409.60	340.00	1295.00	746.00	275.00	100.00	2227.00	1475.00	684.60	440.00
Culled animals	30.00	-	60.00	160.00	1431.00	458.00	300.00	275.00	1461.00	458.00	360.00	435.00
Hide	20.00	10.00	5.00	34.00	17.00	15.00	-	-	37.00	25.00	5.00	34.00
Manure	-	-	-	-	250.00	195.00	225.00	195.00	250.00	195.00	225.00	195.00
Fluid cash	1195.37	755.50	609.60	767.44	3206.50	1629.0	925.50	890.25	4401.85	2384.50	1535.10	1657.69
Assets at end of animals	-	-	-	-	2650.00	1300.00	1040.00	640.00	2650.00	1300.00	1040.00	640.00
Total	1195.37	755.50	609.60	767.44	5856.50	2929.00	1965.50	1530.25	7051.87	3684.50	2575.10	2297.69
Income/animal/month									19.59	10.23	7.15	6.38

Table 4.35: Quantity of items disposed off

Items	I yr.				II yr.				Total			
	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep
Milk(kg)	140.00	11.00	-	-	140.00	148.00	-	-	280.00	159.00	-	-
Wool(kg)	-	-	12.50	23.58	-	-	20.40	38.46	-	-	32.90	62.04
Male hog. (No./kg)	8/ 142.40	8/ 136.8	5/ 78.4	5/ 83.0	15/ 247.7	7/ 125.2	3/ 46.8	1/ 17.2	23/ 390.1	15/ 262.0	8/ 125.2	6/ 100.2
Culled animal adults (No./kg)	-	-	1/ 31.8	1/ 43.2	7/ 214.6	2/ 71.0	5/ 130.0	2/ 70.0	7/ 241.6	2/ 71.0	6/ 161.3	3/ 113.2
Culled animals young (No./kg)	1/ 9.0	-	-	2/ 18.0	2/ 13.5	1/ 13.0	-	1/ 10.0	3/ 22.5	1/ 13.0	-	3/ 28.0
Hide adult (NO.)	1	1	-	3	1	1	-	-	2	2	-	3
Hide young (No.)	1	-	1	1	1	-	-	-	2	-	1	1
Manure (quintals)	-	-	-	-	58.0	45.0	52.0	45.0	58.0	45.0	52.0	45.0
Assets (No.of young animals)												
Above 6 months	-	-	-	-	15	6	6	3	15	6	6	3
3-6 months	-	-	-	-	-	-	-	1	-	-	-	1
Below 3 months	-	-	-	-	8	8	11	7	8	8	11	7

Table 4.36: Expenditure on maintenance and up-keep of sheep and goat (Rs.)

Items	I yr.				II yr.				Total			
	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep	Native goat	Cr.bred goat	Native sheep	Cr.bred sheep
Medicine curative	109.17	60.07	42.21	104.84	114.83	108.30	233.49	242.71	224.00	168.37	275.70	347.55
(Av.animals /month)	(25)	(22)	(22.4)	(23.5)	(38.5)	(24.8)	(24)	(22.3)	(31.8)	(23.5)	(23.2)	(22.9)
Preventive	31.90	31.90	36.10	36.10	38.36	36.26	36.26	35.66	70.26	68.18	72.36	71.76
Mineral bricks	18.00	18.00	18.00	18.00	27.00	27.00	27.00	27.00	45.00	45.00	45.00	45.00
Shearing	-	-	19.20	33.50	-	-	27.00	42.00	-	-	46.20	75.50
(No.of animals)			(40)	(37)			(45)	(42)				
Miscellaneous	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	50.00	50.00	50.00	50.00
Replacement (Rs./No.)	-	105.00 (1)	45.00 (1)	630.00 (6)	140.00 (2)	-	-	-	140.00 (2)	105.00 (1)	45.00 (1)	630.00 (6)
Total	184.07	239.97	185.51	847.44	345.19	196.56	384.75	372.37	529.26	436.53	534.26	1219.81
Expenditure/animal/month									1.47	1.21	1.48	3.39

Table 4.37: Net return through sheep and goat (Rs.)*

	Native goat	Cross-bred goat	Native sheep	Cross-bred sheep
Gross income	7051.87	3684.50	2575.10	2297.69
Expenditure	529.26	436.53	534.26	1219.81
Net income	6522.61	3247.97	2040.84	1077.88
Net income/ animal/month	18.12	9.02	5.67	2.99
	13.57**		4.33**	

* Economics based on 15 breedable female, one male and their followers for a period of 24 months

** Species average

Table 4.38: Economic return from native and cross-breed sheep as per market trend (Rs.)

Income through sale proceeds

Items	Native sheep	Cross-bred sheep
Wool	260.50	1240.00
Male hoggets	684.60	440.00
Culled animals	360.00	435.00
Hide	5.00	34.00
Manure	225.00	195.00
Assets	1040.00	900.00
Total	2575.10	3244.80

Expenditure on maintenance and upkeep of animals

Items	Native sheep	Cross-bred sheep
Medicines -		
Curative	275.70	347.55
Preventive	72.36	71.76
Mineral bricks	45.00	45.00
Shearing	46.20	75.50
Miscellaneous	50.00	50.00
Replacement	45.00	270.00
	(1)	(3)
Total	534.26	859.81

Net return through native and cross-bred sheep (Rs.)

Item	Native sheep	Cross-bred sheep
Gross income	2575.10	3244.80
Expenditure	534.26	859.81
Net income	2040.84	2389.99
Net income/animal/month	5.67	6.62

CHAPTER - V

S U M M A R Y

S U M M A R Y

The study conducted to determinate the relative performance of sheep and goat in semi-arid region under free range grazing management in terms of production potential, nutritional status, influence of physical environment on animal performances and relative economics among native and cross-bred sheep and goat resulted in to the following conclusions:

1. GRAZING BEHAVIOUR WITH REFERENCE TO DISTANCE TRAVELLED

a) The average foot step of goat (48.065 cm) was higher than sheep (38.415 cm), which may be due to their difference in height at whither.

b)The average foot step had more or less similar relation with the height of the animal (native and cross-bred sheep and goat) averaging to 0.59872 $\pm$ 0.00117 times of the height at whither.

c) Considering the height of the animal as radius and the foot step as a part of the circumference, the average angle of movement of leg was found to be 34.3 $\pm$ 0.134 degree.

d) Average distance travelled per day by goat (14.304 km) was higher than sheep (10.166 km).

e) Native sheep as well as native goats were found to travel more than respective cross-breds (10.625 Vs. 9.708 km for sheep and 14.784 Vs. 13.824 km for goat), which may be due to better adoptability of natives over cross-breds.

f) The distance travelled per day by sheep as well as by goats was negatively co-rrelated with physical environment in terms of THSI and varied significantly ($P \angle 0.05$) in sheep only.

ANIMAL PERFORMANCES

I. Influence of physical environment on adult body weight changes:

During summer with highest THSI, the native animals declined in the body weight at a lesser magnitude than cross-breds, being more acclimatise to the harsh climate for generations. However, the decline in summer may be due to poor availability of grazing resources coupled with hot environment.

II. Growth rate of Lambs and Kids:

a) The males were found heavier than females at birth, weaning and six months of age in both the species, and was 15.47, 23.70, 13.36 and 8.04, 1.36, and 14.12 percent among goat and sheep respectively.

b) The cross-bred kids were found heavier than natives at birth, weaning, six and twelve months of age and the higher birth weight(10.4%) varied significantly ($P \angle 0.05$).

c) The cross-bred lambs were significantly($P \angle 0.01$) heavier (17.6%) at birth, but at subsequent stages of growth natives were heavier, which may be due to their better adaptability. The higher body weight of native lambs at twelve months of age (25.89%) varied significantly (P∠0.01).

d) The average daily gain in cross-bred kids were higher than native kids during pre-weaning, post-weaning while it was reverse between 6-12 months of age.

e) Average daily gain among native lambs were higher during pre-weaning and between 6-12 months of age, while the pre-weaning gain was almost similar.

III. Influence of Physical environment (THSI) on pre-weaning gain:

a) The pre-weaning gain in native and cross-bred sheep and goat irrespective of sex was found significantly (P∠0.05) and negatively co-rrelated with the physical environment (THSI) to which they had exposed from birth till 3 months of age.

IV. Lactational performances of goats:

a) The lactational length and lactational yield in cross-bred goats were non significantly higher than natives.

b) The peak yield was obtained during third fortnight of post kidding in both the breeds but the peak continued through fourth fortnight only in cross-breds. The peak yield was 450 g and 460 g/day in native and cross-breds, respectively.

c) The milk yield remained above average both in native and cross-breds from first till seventh fortnight of post kidding.

d) The milk yield remained peak during the month of December followed by January, simulating peak vegetation resources.

V. Greasy fleece yield:

a) The annual greasy fleece yield among cross-breds were significantly ($P<0.01$) higher (105%) than natives.

b) Greasy fleece yield per kg. body weight from adult cross-breds were significant ($P<0.01$) higher (70.7%) than natives.

c) Greasy fleece yield from both native and cross-breds was low during autumn compared to spring season. This may be due to high humidity accompanying with high atmospheric temperature during autumn compared to spring. The seasonal difference in wool yield varied significantly ($P<0.01$) only in cross-breds.

d) Greasy fleece yield from native as well as cross-bred lambs adjusted for 180 days of age was found to be almost equal.

e) Greasy fleece yield per kg. body weight was non-significantly higher (6.7%) in cross-bred lambs than natives.

f) Greasy fleece yield from lambs per 100 hours of day light was higher (18.75%) in cross-breds than native lambs without any significant difference.

VI. Reproductive performance of sheep and goat:

a) The age at first kidding was found less by 190 days compared to the age at first lambing. The kidding interval was also less by 50 days than the lambing interval indicating prolificaly of goats over sheep.

b) The body weight at first kidding was similar both in native and cross-bred goat while it was non-significantly higher in cross-bred sheep compared to the native sheep.

c) The kidding interval in native goat was significantly ($P \angle 0.05$) lower (89 days) than cross-bred goats but the lambing interval was non significantly higher (15 days) among natives than cross-bred sheep.

d) Both sheep and goat was found to be non seasonal breeder. The breeding activity in general remained peak during July and November, indicating negative co-rrelation with hours of day light and positive co-rrelation with THSI.

e) The peak lambing/kidding was found to occur between the months of December and March while there was neither lambing nor kidding during July.

f) The incidence of animals parturated twice in a year was 53% in native goat, 6.7% each in cross-bred goat and native sheep and 10% in cross-bred sheep, respectively.

g) The animals produced twine was 26% among native goats, 12.5% in cross-bred goat, 3% in native sheep and 3.7% in cross-bred sheep, respectively.

h) Number of progeny born per parturation was highest in native goat (1.261) followed by cross-bred goat (1.125) cross-bred sheep (1.039) and native sheep (1.029), respectively.

i) The kidding percentage among native goat was 153% and in cross-breds it was 106%. The lambing percentage was 106% in native sheep while it was 90% in cross-bred sheep.

j) The number of progeny born/100 animal/year was thus 193, 120, 110 and 93 among native and cross-bred goat, native and cross-bred sheep, respectively.

k) The over all reproductive performance was found higher under incentive based managemental system compared to conventional management, which may be due to better care and nourishment of animals in the former than the later ones.

VII. Adult and young mortality in sheep and goat:

a) The annual adult mortality was higher in cross-bred sheep (16.6%) followed by native goat (10.0%), Cross-bred goat (6.6%) and native sheep (nil), respectively.

b) In general the kids had a lower mortality rate at various stages of growth compared to lambs. Among the lambs the cross-breds had a higher rate of mortality than natives.

c) The major cause of mortality was predation, accounting to about 60.0% in both the age groups.

d) The predation, both in adult and lambs was higher in summer followed by winter. This may be due to late evening grazing of animals coupled with undulated topography of the grazing area.

3. NUTRITIONAL STATUS OF SHEEP AND GOAT

a) The nutritive value of feed/fodder was observed to very with the change of THSI. During summer (June) with elevated THSI, the availability of digestible nutrients from the feed/fodders was the lowest and was highest in winter (December) when the THSI was lowest.

b) The dry matter intake both by native goat and native sheep was highest during summer with elevated THSI, which might be due to their adaptability to such hot environment since generation, in order to derive their nutrient requirements from low quality feed/fodder resources.

c) The dry matter digestibility among all groups of animals was apparently on lower side. This may be to the over estimations of faecal output through chromic oxide technique. Over estimation of faecal output to the extent of 11-24% was reported earlier by various workers while using chromic oxide as an indicator for digestibility trials.

d) In general, goats were found better digester of crude fiber, crude protein and nitrogen free extract than sheep .

e) The availability of DCP neither for native nor for cross-bred goat was adequat from the grazing area during June. In addition, the cross-bred goats also failed to obtain optimum amount of DCP during March. The DCP availability was also inadequet for native as well as cross-bred sheep round the year except during December.

4. RELATIVE ECONOMICS OF SHEEP AND GOAT

a) The gross income was higher from native goats followed by cross-bred goat, native sheep and cross-bred sheep and the ratio was 100:52.25 : 36.52 : and 32.58, respectively.

b) The expenditure on maintenance and up-keep of the animals was higher in cross-bred sheep followed by native sheep, native goat and cross-bred goat and the ratio was 100:43.80:43.39 and 35.79, respectively.

c) The net income/animal/month was higher in native goat (Rs.18.12) followed by cross-bred goat (Rs.9.02), native sheep (Rs.5.67) and cross-bred sheep (Rs.2.99) and the ratio was 100:49.78 : 31.29 and 16.50, respectively. The net return indicated the superiority of goats over sheep by 213.4% which may be due to higher fecundity, low mortality and less expenditure on maintenance and up-keep of goats compared to sheep.

d) Among breeds, the net return from native goat was higher than cross-breds by 101% and in sheep it was higher in natives by 89.6% than cross-breds. This may be due to better adaptability of natives to the local climate, thereby incurring less expenditure on maintenance and up-keep and higher return through sale proceeds of different items.

5. ECONOMIC OF SHEEP AND GOAT UNDER DIFFERENT MANAGEMENTAL SYSTEM

The economics based on the productivity of 30 native (Malpura) sheep and 30 native goats with one breeding males from each of the two species under natural degraded range land over a period of three years at Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) through conventional managemental system indicated average net return of Rs. 690.49 fluid cash per year after paying 10% interest on the loan incurred for the non-recurring expenditures at the begining, repaying 10% of the loan every year and meeting expenditures on maintenance and up-keep of the animals. The difference between asset and liabilities after three years provided an additional income of Rs. 1104.66 per year, thereby raising the total income to Rs.1795.15 per year. When the total income was apportioned between sheep and goat it was Rs. 0.03 per sheep and Rs.4.96 per goat per month. Under productional remuneration managemental system the net income from similar animals (native sheep and goat) under similar range land was Rs. 5.67 per sheep and Rs.18.12

per goat per month, thus making the average income in to a ratio of 1:4.77 between conventional and incentive based system (Rs. 2.49 Vs. 11.89). The difference may be attributed mainly to the human interference under conventional farm managemental system where the experiment are conducted through uncomitted, regularly paid workers involving lot of expenditure Vs personal attention including more grazing hours in the cooler parts of the day in production remuneration managemental system.

Result thus obtained from the above farming system will definitely serve a model for interested small/marginal farmer and attract them towards livestock enterprises due to immediate return without much initial investment and attaining self sufficiency within few years. This will also serve as a model for the agencies working for the small/marginal farmers to switch-over from their traditional practices i.e. working as a mediator for providing loan to the farmer from the bank and subsidy from the government, to provide animals directly to the farmers with the condition to take back the same number of animals after certain period. Due to personal care and management, the farmer will definitely become self sufficient with the surplus animals. Since, the agency is sure to get back the same heads of animals with proper watch and ward, it will not be in loss, rather can help many farmers with the initial investment only.

Based on this calculation, it may be reasonably concluded that, any farmer who wishes to earn a minimum monthly income of Rs. 300=00 to 500=00 for his livelyhood can obtain the same by maintaining 30 goats.

CHAPTER - VI

C O N C L U S I O N

C O N C L U S I O N

The livestock in the dryland agriculture has enough potentiality to improve the economic status of marginal farmers as well as landless agricultural workers. Among all type of livestock the role of sheep and goat is of paramount importance.

The National Commission on Agriculture, the Govt. of India and other organisations have introduced various schemes, the purpose of which is to augment the animal production as a whole and to improve the financial position of the farmers.

Keeping these points in mind, the present investigation was undertaken to asses the applicability of sheep and goat husbandry in the semi-arid region by farmer who may be classified as a marginal farmer.

Sixty acres of uncultivable, unfertilized land was used to rear 15 native and 15 cross-bred sheep and 15 native and 15 cross-bred goat under identical conditions. The investigation was continued for two years. Since, the investigation could not be continued beyond the second year, as such the efficiency of the total land with respect to grassland cover could not be ascertained. However, under such circumstances the question of overgrazing if any, can not be rules out if the total stock exceeded the total bearing limit of the land. The droppings of sheep and goat contains organic nitrogenous matter and these are added to the soil as a source of NPK fertilizer. The soil is expected to get more of organic fertilizer as and when the stocking rate is increased.

At the onset of the experiment, the stocking rate irrespective of species was similar i.e., one animal per acre. The total grass cover was 4.28 percent. With the progress of the days, the number of animals in each species increased depending upon the reproductive performances. In the second year the stocking rate for all these four groups varied. Inspite of that the grass cover appeared to be uniform. This observation indicated that on the whole the stocking rate for all the groups could sustain the animals for productive purpose. Adverse natural calamity may happen and creat scarcity of vegetation cover. Under such situation the question of overgrazing may be avoided with rotational plot grazing within the specified area.

The present work suggest that one acre of land per animal irrespective of species or breed can not only sustain the animal but help in the production.

Considering the body weight as an index, it was found that the animals could not maintain progressive increase in body weight throughout the year irrespective of physiological status. However, on most of the occasions, the growth performances was appeared to be satisfactory. It may be presumed that the animals could have recorded steady increase in the body weight provided, the nutrition from the grazing land would have been optimum. It is, therefore, assumed that the available area under consideration would sustain the animals during certain periods of the year but could not provide the optimum nutrition as required for physiological processes.

The grass coverage which was about 4.0 percent had the potentiality for improvement with good pasture managemental practices. At the end of the experiment it was assumed that there was no dearth of fertilizer on the land which was made available from the excreta of the grazing animals. Though the experimental data did not furnish any relevant informations, even though it may be assumed from the figures that the stocking rate may be increased during certain parts of the year, particularly during the months of September-October. On the other hand, to combat a decline in the body weight the stocking rate could have been decreased during summer to obtain a better performance.

It may reasonably be questioned on the validity about the reproducebility of these information in parts other than the semi-arid condition.

Based on the conclusion i.e., one animal per acre, it may be said that, barring the hilly areas, the maintenance of the animals at the same stocking rate is expected to be promising. In areas where the rainfall is evenly distributed, the grass cover is expected to be much more better and as a result there is every possibility of increasing the stocking rate.

To augment the performance of the native stock, superior genetic material is being introduced by the way of cross-breeding as a national policy of the country. The cross-breeding has been found to be beneficial in most of the conducted experiments. However, in the present experiment, the performance of the native stock irrespective of the species was found superior to their cross-breds in relation to digestive performance, efficiency of utilization of nutrients, reproductive efficiency and multiple births. These observations may lead one to conclude the superiority of the natives over the cross-breds.

It is well known that the manifestation of the productive traits are governed both by genetic and environmental factors. An individual with superior germplasm may not exhibit its full productive potentialities under adverse environmental condition. Digestion, excretion, reproduction and thermoregulations etc. are the various physiological functions which interact with the environment for the adaptation of an animal.

The natives, irrespective of breeds adapted to a particular environmental condition generation after generation are tuned to struggle against very harsh conditions. Their adaptability in relation to solar radiation, temperature and humidity has been found unquestionably superior to the cross-breds. The growth rate, kidding/lambing percentage and the mortality figures of the natives are the indications of their superiority.

Under the existing production system and managerial practices of this experiment it may be said that the Sirohi x Beetal goats and Malpura x Rambouillet sheep did not nick well with native Sirohi goat and Malpura sheep.

The land used in this experiment was unsuitable for any agricultural operations. Therefore, a comparative idea of the return by crop production against animal husbandry could not be obtained.

The estimates derived in this experiment as regards to net outcome with respect to per acre of land on per animal per month was Rs. 1.21 for native goat, Rs.0.60 for cross-bred goat, Rs.0.38 for native sheep and Rs. 0.20 for cross-bred sheep, respectively.

From the performance record with respect to all the production traits the natives were found to be superior to their cross-breds. On the other hand the comparative figures between the species indicated superiority of goats over sheep. The per capita income per month was higher in native goats than the cross-bred goats. As the reproductive rate, incidence of twining are higher in the natives, the subsequent return in the succeding year increased at a higher degree. The higher marketable weight of the natives also added to the return. The total milk production also added favourable points to the credit side. The lower interkidding period reduced the managemental cost which had also a positive effect on the income.

The present experimental site, perhaps had the low incidence of parasitic infestation by virtue of its climatic condition resulting in to low young stock losses. Therefore, the return from the followers as accounted in this present study may not be reproduceble in areas where parasitism is very common or in endemic parasitic area. Even though, the trend of per capita income is expected to be progressively higher from year to year, provided, an uniform managemental practices in relation to pasture management and health cover are attended.

Based on this calculation, it may be reasonably concluded that a farmer is expected to get a return of Rs. 1000/- per month on and from the second year from sixty native goats at a stocking rate of one animal per acre. This return does not include the capital investment on the grazing land. Even if there are natural calamities, it is expected to have a return of Rs.10/- per animal per month. Any farmer who wishes to earn a minimum monthly income of Rs.300/- for his livelyhood can attain the same if he maintains 30 goats.

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A P P E N D I C E S

Appendix - I : Proximate analysis of feed and fodder(% dry matter basis)

Season	Ash	CP	EE	CF	NFE	Lignin	Gross energy (Kcal/g)
			Proximate analysis of feed/fodder for goat				
Spring (March)	9.80	8.40	2.96	28.56	60.08	18.69.	4.386
Summer (June)	7.97	9.80	3.08	30.40	48.75	33.82	5.210
Autumn(September)	9.95	10.85	3.52	26.80	48.88	26.54	5.250
Winter(December)	8.25	13.61	2.89	28.84	46.41	13.68	5.544
			Proximate analysis of feed/fodder for sheep				
Spring(March)	11.20	7.35	2.16	26.72	52.57	20.84	4.352
Summer(June)	6.55	9.10	1.70	28.44	54.21	35.48	4.580
Autumn(September)	11.87	9.45	1.84	29.80	47.04	29.05	4.904
Winter(December)	10.97	11.97	2.75	26.15	48.16	17.63	5.346
			Proximate analysis of faces for native goat				
Spring (March)	18.59	7.52	2.08	20.11	51.70	29.36	4.494
Summer (June)	21.44	8.92	2.86	21.99	44.79	43.24	4.815
Autumn(September)	20.04	9.62	2.63	28.80	38.91	42.61	5.2635
Winter(December)	21.74	10.26	3.19	23.35	41.26	20.45	5.042
			Proximate analysis of faeces for cross-bred goat				
Spring (March)	18.13	7.87	2.22	23.14	48.64	27.81	4.597
Summer (June)	18.79	8.57	2.84	21.93	47.87	41.015	4.575
Autumn(September)	20.90	11.72	3.29	29.04	38.05	44.65	5.3425
Winter(December)	22.12	12.59	3.28	24.64	37.37	21.87	5.216

(Contd...)

Appendix - I (Contd.)

Season	Ash	CP	EE	CF	NFE	Lignin	Gross energy (Kcal/g)
	Proximate analysis of faeces for native sheep						
Spring (March)	21.88	6.83	1.30	22.22	47.77	29.15	3.725
Summer (June)	23.26	9.10	1.46	24.33	41.85	45.37	4.100
Autumn(September)	21.70	8.40	1.88	26.18	41.84	46.54	4.491
Winter(December)	25.26	10.43	3.22	22.01	39.08	26.26	4.851
	Proximate analysis of faeces for Cross-bred sheep						
Spring(March)	20.23	7.00	1.70	24.04	47.03	27.91	3.647
Summer(June)	24.12	8.75	1.56	25.71	39.86	46.65	4.340
Autumn(September)	31.05	9.27	1.51	29.11	29.06	47.78	4.494
Winter(December)	22.20	9.07	2.34	25.29	41.10	24.36	4.851

Appendix- II : Co-efficient of digestion of nutrients(%)

Season	DM	CP	EE	CF	NFE	GF
			For native goat			
Spring(March)	36.30	42.98	55.25	55.15	45.19	34.75
Summer(June)	21.22	28.29	26.85	43.01	27.62	27.70
Autumn(September)	37.60	44.75	53.44	33.04	50.40	37.536
Winter(December)	33.11	49.58	26.17	45.38	40.53	39.17
			For Cross-bred goat			
Spring (March	32.80	37.04	49.56	45.54	45.59	29.56
Summer (June)	17.67	28.00	24.08	40.61	19.16	27.70
Autumn(September)	40.56	35.79	44.44	35.59	53.73	39.51
Winter (December)	37.44	42.13	29.00	46.55	44.07	41.14
			For native sheep			
Spring (March)	28.52	33.58	56.98	40.55	35.05	38.82
Summer(June)	21.74	21.74	32.78	33.04	39.58	29.94
Autumn(September)	37.60	44.53	36.25	45.18	44.50	42.86
Winter(December)	32.88	41.51	21.40	43.51	45.53	39.09
			For Cross-bred sheep			
Spring (March)	25.35	28.91	41.25	32.84	33.22	37.45
Summer(June)	23.94	26.87	30.21	44.08	38.64	22.95
Autumn(September)	39.21	40.36	50.11	40.62	36.66	44.29
Winter(December)	27.66	45.19	38.45	30.04	38.27	34.36

Appendix-III: Body weight changes during experimental period, feed/fodder intake and faecal output in sheep and goat

Season	Initial body wt. (kg)	Final body weight(kg)	Average body wt. (kg)	Feed/fodder intake(kg)	Faecal output (kg)	Intake/kg metabolic body weight(kg)
			For native goat			
Spring (March)	42.2	42.0	42.1	1.374	0.875	83.12
Summer (June)	31.1	31.1	31.1	1.131	0.891	85.88
Autumn(September)	36.6	37.0	36.8	1.016	0.633	68.01
Winter(December)	40.0	40.3	40.15	1.208	0.808	75.74
			For Cross-bred goat			
Spring (March)	34.5	35.3	34.9	1.052	0.707	73.26
Summer (June)	23.8	23.6	23.7	0.764	0.629	71.14
Autumn(September)	34.1	34.5	34.3	1.213	0.721	85.60
Winter(December)	36.1	36.7	36.4	1.167	0.730	78.74
			For native sheep			
Spring (March)	29.0	29.3	29.15	0.838	0.599	66.77
Summer(June)	27.1	27.0	27.05	0.966	0.756	81.45
Autumn(September)	31.5	30.9	31.2	0.936	0.584	70.91
Winter(December)	36.0	36.0	36.0	1.028	0.690	69.93
			For Cross-bred sheep			
Spring(March)	29.7	30.2	29.95	0.915	0.683	71.48
Summer(June)	29.6	29.6	29.6	0.994	0.756	78.33
Autumn(September)	28.2	27.7	27.95	0.913	0.555	75.14
Winter(December)	27.8	28.0	27.9	0.947	0.685	78.01